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ADDRESS AT THE ANNUAL GENERAL MEETING

of the Society held on 24 June 1940, by the President

FIELD-MARSHAL SIR PHILIP CHETWODE, BART., G.C.B., O.M.

WE have lost during the year some very distinguished Fellows.

Lord Howard of Penrith, after a long career in the Diplomatic Service, of which he gave a delightful and instructive account in two volumes of memoirs, became our Foreign Secretary in 1932 soon after his retirement from his last post as His Majesty's Ambassador at Washington. He had been for many years a Fellow of our Society, had taken throughout his life a great interest in our work, and with deep regret we had to accept last year his resignation from the Foreign Secretaryship only a few months before his death.

Major-General Sir Hamilton Bower received as Captain Bower of the 17th Bengal Cavalry our Founder's Medal in 1894 for his remarkable journey from Leh across Tibet, passing some 180 miles north of Lhasa, and coming out by the Batang–Tatsienlu road. He was the first European to make this journey, and only one or two have done anything like it since.

The name of Brigadier-General the Hon. C. G. Bruce is famous in the history of Himalayan exploration. He was one of the first to plan assaults upon Mount Everest. When permission was obtained from the Government of Tibet he led the Mount Everest Expeditions of 1922 and 1924, was almost continually until his death a member of the Mount Everest Committee, and served it several times as President. He received our Patron's Medal in 1925.

Vice-Admiral Sir Percy Douglas had spent most of his life in the Hydrographic Service of the Admiralty, had distinguished himself in 1914–18 on active service in the Mediterranean, and had made his name to be placed high in the distinguished line of Hydrographers of the Navy by his introduction of new instruments and methods, of which I may mention in particular the 45° Prismatic Astrolabe. He had been at the same time greatly responsible for the equipment of the ships built for service in the Antarctic Ocean for the work of the *Discovery* Committee, whose task it was to expend for the benefit of science and the whaling industry the large sums which had accrued to the Falkland Islands Dependencies from whaling royalties. He had served our

Society long as Councillor and Vice-President, and died on active service as Commodore Superintendent at Dover.

Colonel Sir Charles Yate, who died in March at the great age of ninety, had a distinguished career in the Indian Political Service, took part in the relief of Kandahar in 1881, was on the Afghan Boundary Commission of 1884, and in charge at Pendjeh during the critical days of the spring of 1885. He served on our Council for many years, and was one of the most familiar figures at our meetings up to ten years ago.

By the death of Mr. J. F. Baddeley we have lost a distinguished scholar and high authority upon the history of Russian penetration into Asia, where in middle life he had travelled very widely, collecting the materials for his magnificent work 'Russia, Mongolia, China,' and for another nearly completed work on the history of the Caucasus. He received our Victoria Medal in 1922.

Dr. W. N. Neale, who died at about the time of our Annual Meeting last year, was surgeon and naturalist of the Arctic expedition of Mr. Leigh-Smith in the summers of 1880 and 1881. Having to maintain the health of the expedition after their ship had been crushed and sunk in the latter year, he was one of the first to insist on the diet of bear and walrus that kept the whole party in perfect health. He was a Fellow of our Society for nearly sixty years.

Dr. A. C. Haddon, while he was a young Professor in Dublin, made his first journey to Torres Straits in 1888–89, and conducted the Cambridge Anthropological Expedition to that region in 1898–99. On his return he was appointed Lecturer in Ethnology at Cambridge, where he spent the rest of his long life, a principal fountain of learning and advice to generations of geographers.

Dr. R. T. Gunther was until his death a few months ago Director of the Museum of the History of Science, installed in the beautiful Old Ashmolean Building at Oxford when the late Dr. Lewis Evans had been persuaded, perhaps by its Director, to endow the University with his famous collection of antique instruments, especially astrolabes. To this Dr. Gunther, with all the arts of the best museum man, directed a continual flow of beautiful things.

It is too soon to begin to chronicle the losses which must inevitably fall upon us during the present war. I will mention to-day only the Duke of Northumberland, President of the Tyneside Geographical Society, reported killed in action, and Sir Arnold Wilson, for some years a Member of our Council, who is reported missing.

In my Address last year I spoke of a number of expeditions which were then in the field. Mr. Ronald Kaulback has returned from his work with Mr. L. St. C. Bartholomew on the north-east borderlands of Burma, but his military duties have made it impossible for him to give us any account of that work. Mr. Bennett has sent us from India an instalment of the work of the British Canadian Arctic Expedition, which has been published. Mr. Patrick Baird came back some months ago in the uniform of a Canadian regiment, and we have had no news of Mr. Manning, who is so far as we know continuing the work. Dr. J. V. Harrison returned from the Andes of Central Peru towards the end of the year and gave us an excellent paper on his results in the spring. We have heard also from members of Dr. Chapman's party

an account of their studies of coral and mangrove in and about the island of Jamaica. Mr. Eric Shipton, Mr. P. G. Mott, and Mr. Scott Russell had to break off their Karakoram Expedition when they heard in October of the outbreak of war. The last named gave us an admirable account of their important results. Messrs. Shipton and Mott are believed to be on military service in India.

The Karakoram Map which has been under construction for a number of years is now on sale as a special publication. It was, you will remember, begun to provide the basis for discussion and agreement upon the range and peak names of the Karakoram, and it served its purpose well for a conference between the Survey of India and ourselves, which met in London in March 1937 and came to an excellent agreement, thanks greatly to the enthusiastic work of Professor Kenneth Mason. I commend this map to you as a striking representation of one of the most difficult regions in the world.

Just before the end of the session we have heard at one of our meetings the final account of the surveys of the British Graham Land Expedition from its Chief Surveyor, Mr. Alfred Stephenson, and we look forward to seeing the publication of this paper at an early date, because he has succeeded in setting out clearly the relations to the British land surveys of the photographs taken by Wilkins and Ellsworth, whose interconnection had been worked out very skilfully by Mr. W. L. G. Joerg, but which could not be tied to earth until Rymill's land positions became available.

And here I would refer to another Antarctic map which was published last September. When Mr. Lars Christensen was in London and gave us a paper on recent reconnaissance flights in the Antarctic, we formed the plan of trying, not to decide between rival Norwegian and British names along the coast of the Australian Antarctic Territory, but to show upon one map both the British and the Norwegian work and names, in different colours, overlapping. This would, we believe, provide the basis for friendly discussion. A visit of the Secretary to Oslo in August 1938 ensured that our representation of the Norwegian case was complete, and correspondence with the Australian Government did the same for theirs. We hope that in less troubled days this careful presentation of the two cases on a single sheet will be useful in coming to a friendly agreement.

A third Antarctic matter in which we have been concerned is the history of the discovery of Graham Land, a memoir on which was widely circulated from Philadelphia. It claimed the honour for Captain Nathaniel Palmer, and attempted to eliminate the prior discovery of Bransfield and Smith by asserting that the principal documents in the possession of the British Admiralty were spurious. In a long and careful review of this memoir in the *Journal* for October 1939 we have examined the propositions of Professor W. H. Hobbs and have shown why the British cannot accept them.

When in 1939 His Majesty's Government undertook to provide for British participation in the proposed Arctic Exhibition and Congress at Bergen this year, the Society very willingly promised to provide part of the British exhibit and to design a scheme of decorative maps to adorn the British pavilion. In October last we heard that the Norwegian authorities had felt compelled to abandon the proposed exhibition, but we then had little thought of the fate

that was soon to overtake the city of Bergen. A sketch for one of the decorative maps will be found in the *Journal* for May.

The Report of the Council is in your hands, and I ask your attention to the first section which deals with the Fellowship of the Society. We cannot expect that there will be no diminution in our strength, but do most earnestly desire of all Fellows that they shall do everything possible to enlist new Fellows to replace those who have been compelled to withdraw, and shall resolve that our work as a leading geographical society shall not be hampered by lack of support at this time, when it has a considerable part to play in the national effort for victory. The Report sets out, and I need not repeat, all that has been done to strengthen and safeguard the House and its collections, and our resolution that the work of the Society shall be maintained at its House in London.

About half the House has been scheduled by His Majesty's Office of Works and further strengthened and prepared for Government occupation in case of need. Our staff has been depleted by recalls and calling up for military service. Those who remain have laboured most loyally to carry on the Society's work and to protect its great possessions.

The Cockpit mountains, Jamaica

Salt pans, the main industry at Anguilla

Brimstone Hill, St. Kitts

English Harbour and Falmouth Harbour (background), Antigua

THE WEST INDIES IN 1939

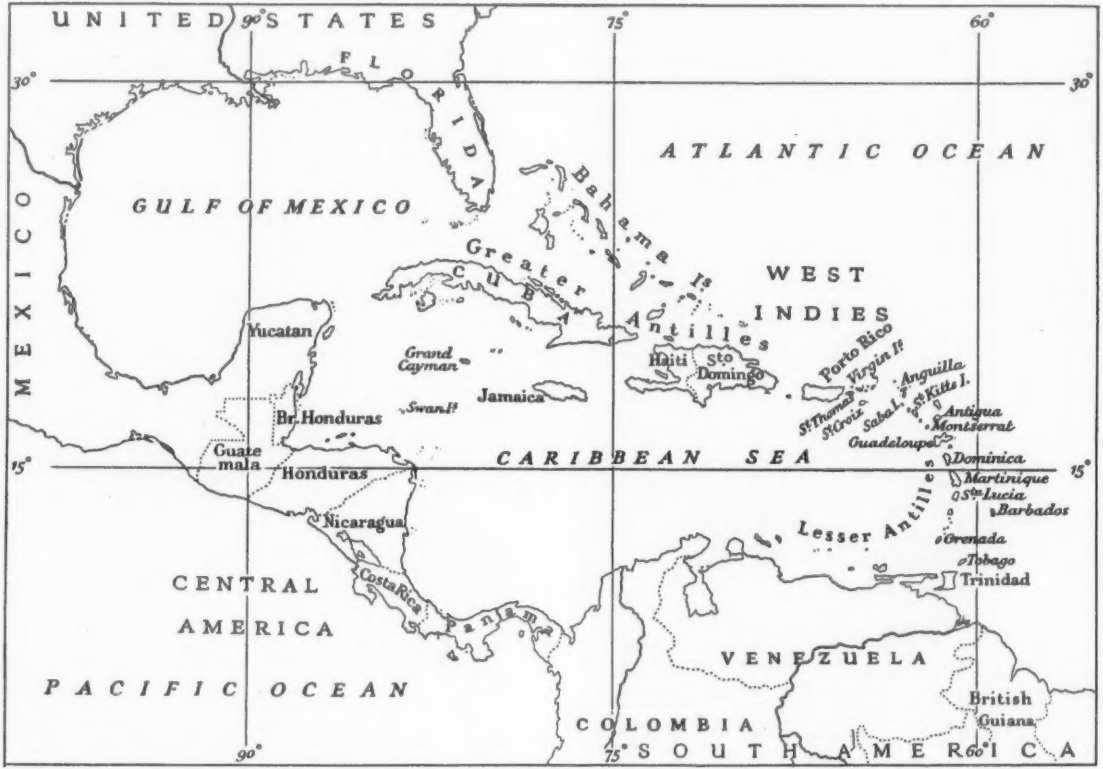
LORD MOYNE

Meeting of the Society, 6 May 1940

NOT being an expert in any branch of geographical science, my only excuse for this paper is that as Chairman of the recent Royal Commission I had exceptional opportunities for seeing the West Indies from British Honduras to British Guiana. During a five months' journey covering 21,000 miles we were enabled to overcome the transport difficulties which are apt to restrict the movements of many travellers. We not only took evidence estimated to amount to about 10 million words on conditions and problems in the British West Indian Colonies and Presidencies, but were also afforded opportunities of comparison with the neighbouring territories under Central American, Cuban, French, U.S., and Dutch administration.

The present shape of the West Indies originated mainly in the Oligocene period: the islands are the summits of a chain of mountains formed by the raising to great heights of land which had, during the early Kainozoic period, been deeply submerged. The mountain chain divides into two in Haiti, and having first gone to Guatemala, my journey was eastward along the southern fork of the two convergent and partially submerged ranges of the Caribbean Andes. I joined the rest of the Commission in Jamaica and we followed the line of islands through to their south-eastern end where they strike the coastal mountains of Venezuela and Trinidad. The Antilles may, during the mountain building period and before the subsequent subsidence, have formed a continuous land bridge between Honduras and Florida in the north, extending possibly to South America, and certainly as far as the Lesser Antilles (in view of remains of *Megatheria* which have been found in Guadeloupe). On the way to Jamaica, on Swan Island, a tiny uninhabited patch of limestone rock 200 miles from the nearest Cayman island, I found living evidence of the land connection which must have existed before the mountains began to subside, in the capromys, a rodent of which various species exist on the isolated groups of Swan Island and the Caymans, and also in Cuba and Jamaica.

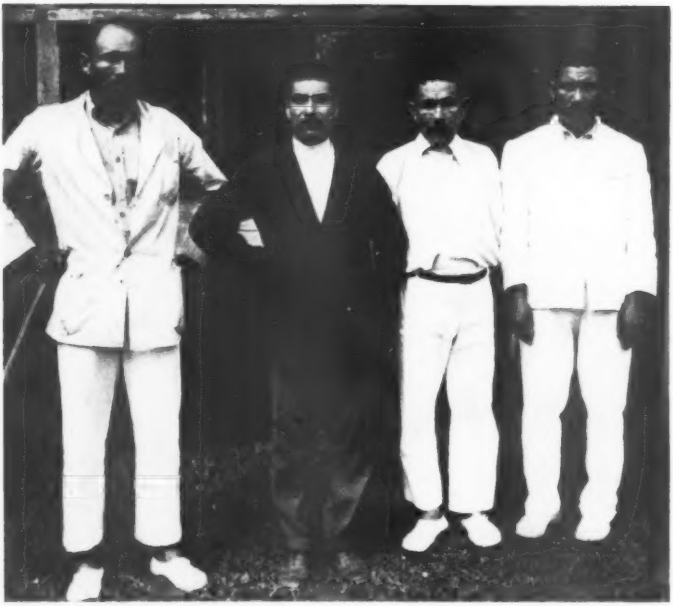
The geological character of the Lesser Antilles differs from that of Haiti and the greater islands to the west. It is doubtful whether the land here ever sank to the same depths, and volcanic activity has continued throughout the Kainozoic period down to the present day. W. M. Davis has worked out the varying ages of many of the islands on the evidence of subsidence revealed by embayed coasts and the effect of glacial times in arresting reef growth and causing platforms and cliffs by low level abrasion. By this method he has shown St. Kitts, by the absence of subsidence and wave-cut cliffs, to be a very young volcanic island. The Dutch island Saba is also a new volcanic cone 2 miles in diameter and ½ mile high, carrying a population of over 300 to the square mile. The people show great ingenuity in finding means of existence: for example, they build boats for sale in inter-island traffic from local wood in the old crater, and in the absence of any harbour these have


UNITED STATES
90°
75°
60°
30°
FLORIDA
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
Bahama Is.
Greater
CUBA
WEST
INDIES
Antilles
Yucatan
Grand Cayman
Haiti
Sto Domingo
Porto Rico
Virgin Is
Anguilla
St Kitts I.
St Thomas
St Croix
Saba I.
Antigua
Montserrat
Guadeloupe
Swan Is
Jamaica
Br. Honduras
Guate mala
Honduras
CARIBBEAN SEA
15°
Dominica
Martinique
St Lucia
Barbados
Nicaragua
Lesser Antilles
Grenada
Tobago
Trinidad
Costa Rica
Panama
CENTRAL
AMERICA
VENEZUELA
PACIFIC OCEAN
British
Guiana
COLOMBIA
SOUTH AMERICA

Derelict sugar mill, Nevis

Nevis from Mount Misery, St. Kitts

The uplands of Montserrat, formerly under cane



Local council in the Carib Reserve, Dominica

to be lowered down over the cliffs. The American island of St. Thomas and the British island of Montserrat are old enough to have lost many of the original volcanic outlines and have drowned valleys and headlands ending in cliffs. The only volcano recently active is Mont Pelée, Martinique, where in 1902 40,000 people instantaneously lost their lives in the destruction of St. Pierre. Hot gas burst out of the mountain and flowed over the town. Owing to the absence of oxygen, articles were fused and destroyed without combustion, so that food, furniture, and people were turned to carbon by destructive distillation. The only survivor was a man who had been put in prison for the night for infringing some trivial local regulation.

The origin of the West Indian islands and the intrusion of Plutonic rocks among the volcanic tuffs, together with the alternating elevations and subsidences during which coral rocks and deep-sea deposits were formed, explain the varied soil. This has its counterpart in the great variety of products and vegetation which has also been encouraged by great contrasts of climate. The rainfall for instance in the single island of Jamaica varies by districts from 30 to 220 inches in a year, and some islands such as Anguilla, consisting mainly of coral rock, suffer so seriously from drought that the population pressed us above all to help them to get deep bored wells in the optimistic hope that this would give them a continuous water supply.

The people are as varied as the soil and climate. Descendants of the Maya Indians are still a valuable element in British Honduras, and various Amerindian tribes survive in British Guiana. In the islands however the original inhabitants are practically extinct except for a small Carib reserve in Dominica. The population is descended from races introduced mainly in the last three centuries from Europe, Africa, East India, and China, and having no native civilization aspires generally to the political and social standards of Great Britain and the United States.

From the earliest days of West Indian colonization, development has concentrated on the export of tropical produce rather than on self-sufficiency and the people continue to live very largely on imports of foreign food which are exchanged for their sugar and other tropical crops. Barbados spends £4 1*s* per head on imported food as against a total export of £8 6*s* per head. An explanation is here to be found in the extreme of overcrowding, 1861 persons per square mile of cultivable land. There is no such reason however in the case of British Honduras, where food is imported to the value of £4 5*s* per head against a total export, mainly of mahogany, of £5 8*s* per head. In this Colony, the population per square mile of usable land, which has here been computed to include forest land, is only 9·4 per head, that is, just one two-hundredth part of the density of agricultural congestion to be found in Barbados. There is no doubt that the West Indian Colonies make a bad bargain by buying tinned meat, tinned milk, and cereals from temperate climates at high prices in exchange for the low-priced tropical crops which they sell in a glutted world market.

Our inquiry was continually being brought back to the agricultural problem as the economic foundation of West Indian life. There is indeed oil and asphalt in Trinidad, timber in British Guiana and British Honduras, and minerals in British Guiana, but in the island colonies without exception the

basis of existence is agricultural. It is to be hoped that secondary industries, such as tinning milk and possibly the production of cement, may be developed in Jamaica and elsewhere, but the main prospect of improvement must ultimately be based on agriculture. West Indian agriculture is peculiar in that even the small cultivators prefer to grow cash crops rather than food crops. They like to sell cane or bananas rather than produce food for family consumption. Here too they make a very unfavourable bargain: instead of growing maize or pulses they spend their money on bread which, being bought in small loaves, works out at about 3*d* a lb., a higher price than that ruling in Great Britain. These unfortunate habits are partly responsible for the very low general standard of life, and the most obvious line of improvement is for the West Indies to produce more food for their own consumption.

This is no new problem, though it has become more acute owing to the increase of population. The Royal Commission of 1897 approached it from another point of view and recommended the development of land settlement. It has not however been possible to reach a solution on these lines, partly for the reason I have just given that the peasant prefers to grow cash crops and partly because the general level of agricultural efficiency is extremely low. Bullocks are used for ploughing on sugar plantations and are gradually being displaced by tractors. Peasant agriculture however is almost entirely by hand. Even if the cultivators had the means to buy implements, their holdings are often on such mountainous land that they could not be used. Livestock and pen manure are therefore no part of the system, and artificial fertilizers are unknown. There is no attempt to maintain soil fertility by rotation of crops and consequently a system of shifting cultivation is generally followed. This means that the land is used only on an average about one year in four, and when the fertility has been exhausted the cultivator breaks up a fresh area. There are therefore large tracts in the West Indies of what is aptly known as ruinate land, which are too much impoverished to be worth cultivating or even to give pasture to livestock.

Agricultural improvement is much discouraged by the present insecurity of tenure. Labourers often have to build their houses on land which they do not own and which often belongs to the estate on which they work, and the present system of tenure among cane farmers and small tenants appears frequently to be very unsatisfactory. One of the worst features is known as share cropping. Many plantations which have become uneconomic have been let out to tenants on the basis of the owner selling the crop of the tenant and receiving up to half the proceeds. Neither party under such conditions has any inducement to spend either money or labour on keeping up the fertility of the holding. The problem of land tenure is of course extremely complicated, and while the Governments seem in many cases to be alive to the need of reform, a careful survey of peasant agriculture is essential before an equitable and economic system can be established.

General improvement in the West Indian standard of life cannot be achieved without transforming agricultural methods. The increased population has outgrown the available land, and a great transfer of activity will have to take place to enable the Colonies to become self-supporting. Professor Engledow has calculated that if existing cereal and pulse imports were to be

replaced by home production, on the basis of an average yield of half a ton to the acre, Jamaica would need to devote to this crop a further 150,000 acres out of her total land area, cultivable and otherwise, of 2,906,000 acres. Trinidad would have to find 120,000 acres out of her total of 1,191,000. Little could be done in this direction in the extreme case of overcrowded Barbados, as it would involve the dedication of 48,000 acres to pulse crops out of the total area of 106,000 acres, which evidently would be impossible. Professor Engledow's figures do not deal with the land equivalents for imported meat, condensed milk, and butter, but he suggests that if Trinidad were to achieve self-sufficiency also in these products it would be necessary to double the area required for the pulse crops.

It would of course be disastrous to carry such changes to the extent of destroying plantation agriculture and especially the sugar industry. Sugar cane must remain the main foundation of external trade. Generally speaking, the plantations and factories are now very efficient, and even though drought causes a fluctuation in sugar yield there is no plantation crop so well suited to West Indian conditions, as it can be grown for long periods on the same ground without any rotation and also because it is far freer from both pests and plant diseases than other export crops such as bananas, limes, or cocoa.

The greatest problem which confronts the West Indies is the steady growth of population right up to and even beyond the limit of subsistence. The population is based on somewhat uncertain estimates, but the generally accepted figure for 1896 is 1,719,000 and for 1936 2,514,000. The rate of increase varies in the different Colonies, but the present annual rate of increase may be taken as fully 1^{1}_{2} per cent. and on the basis of present tendencies it is likely to approach 2 per cent. in the near future. In view of the lack of any important mineral resources, the limited area of fertile land, and the adverse trend of selling prices in the export market, it is evident that the continuance of the present West Indian birth-rate threatens the maintenance of even the present standard of living. Many who are not familiar with the problem and who see the great differences in the density of population, ranging from 3·8 per square mile in British Guiana, 6·62 in British Honduras, up to 1210 in Bardados, imagine that the solution could be found by redistribution. Looking at a map this may seem reasonable if one ignores the quality of land. Of the 68 million acres in the West Indian Colonies, the islands only make up 5 million acres and the continental colonies of British Honduras and British Guiana make up the balance of 63 million. Unfortunately there is no considerable area of suitable agricultural land not already fully occupied.

We are familiar with the tragic story of how Sir Walter Raleigh was brought to his doom by his belief in an El Dorado in the Guianas, and it is curious that the obsession still continues that British Guiana is a country of untold wealth. It is true that the country has not been fully surveyed and that such survey might add to the mineral resources so far proved. There is however no evidence in favour of the schemes which have been put forward for settling a population of up to a million in this Colony. Agricultural activity is limited to a coastal strip of alluvial mud. It is subject to flooding by the sea and by the rains and is only kept in cultivation by costly drainage which

has caused great financial embarrassment and is mainly responsible for what, in so poor a country, is a crippling public debt of £15 a head. Further land settlement would involve very costly drainage schemes in these coastal districts, and the experience of the existing drainage areas makes it clear that the occupiers could never pay off the capital charges and would probably find it impossible even to meet the cost of maintenance. South of the coastal strip the forests, covering 87 per cent. of the whole area of the Colony, grow on sandy soil of very poor agricultural value, and the survey recently carried out by an American Commission in the Rupununi area in the south of British Guiana, in connection with the possibility of Jewish settlement, did not produce encouraging results.

In the islands themselves the suitable land is generally already cultivated, and it would be extremely dangerous to carry cultivation on to the higher slopes. Already by the destruction of forests and the planting of crops, disastrous erosion is taking place in certain Colonies. At the time of our visit to St. Lucia there had just been a disastrous landslide, causing 121 deaths and serious injuries to many others, and a contributing factor is said to have been the clearing of steep slopes for cultivation.

This account of agricultural conditions is rather depressing and this is not the occasion, nor is there time, to detail the improvements which can and should be made. Valuable research work has been done in recent years at the Imperial College of Tropical Agriculture at Trinidad and the results already achieved in the development of new varieties and control of pests and plant diseases are encouraging. The sugar plantations have been actively improving their methods, but these advances have not yet touched the problem of peasant agriculture. British financial assistance in the past has mainly been directed to the development of Colonial resources and trade for mutual benefit, and except in cases of emergency, the whole cost of social and welfare services has been borne by Colonial budgets. In view of the increasing population which has far outstripped the production of consumable wealth, the West Indian Colonies have been too poor to provide public services on the scale which would be expected by a civilized European State. This of course applies primarily to the agricultural Colonies, and an exception must be made in the case of Trinidad which is in a relatively prosperous condition through the recent development of oil resources.

It would hardly be fair to reproach Great Britain for the backward state of the internal Colonial services. I have seen something of other Colonial administrations, French, Dutch, and Belgian, and I have also been able to compare the conditions of the smaller self-governing communities such as Abyssinia, Haiti, San Domingo, Cuba, and the Central American Republics. The Governments of the British West Indies in my opinion compare favourably with all these examples. The Virgin Islands of the U.S. have been chosen for a unique experiment: under the New Deal very costly provision has been made for education, unemployment, health, and public utility. But although envy is naturally aroused in neighbouring British Colonies by the expenditure in St. Thomas and St. Croix, I do not think it is reasonable to compare an experiment applying to a population of about 30,000 with the problems of the British Colonial Empire of over 60 millions, while in the

Steep cultivated slopes in Tobago

Squaring logs of greenheart, British Guiana

Pitch Lake, Trinidad

Bullock carts waiting for cane to be weighed, Trinidad

Castries Harbour, St. Lucia

other U.S. island of Puerto Rico the housing and health conditions give no ground for envy to the British West Indies.

Without British help it is beyond the power of the West Indian Colonies to achieve their own salvation. Everything possible has been done by officials and teachers, who have put up with lower scales of pay than elsewhere in the Colonial Empire and who have made gallant efforts to build up health, education, and other social services on hopelessly inadequate resources. The local revenues of these Colonies amount to less than 7 millions a year, and it will be realized that the additional million pounds a year which the British Government have now promised for welfare work will enable great improvements to be made. This sum will suffer no deduction for the cost of the Comptroller of the West Indian Welfare Fund and his expert staff whom, as a result of our recommendations, the Government have just agreed to provide, nor will it cover the cost of agricultural and other researches and the application of their results, as separate finance is promised for these basic needs.

Great vision and skill will be needed in reorganizing life in the West Indies. With the exception of a small number of aboriginal Indians on the mainland, practically the whole of the population of the West Indies has been settled there during the last three centuries and is of mixed race, from Europe, India, Africa, and China. The social problems therefore resemble those of this country rather than the conditions of Colonies with old-established native civilizations. In their standards of life the people aspire to those of Europe and the U.S.A., but conditions are so different that West Indian problems will have to be solved on new lines, without excessive regard for what has been done elsewhere.

There is certainly a great desire for social improvement, and the Royal Commission was appointed owing to the discontents and the disturbances which it caused. The low standard of life has not unnaturally been attributed by certain elements of the population to political conditions, though, as I have tried to show, the causes are in fact much deeper and due to intrinsic economic reasons which no alteration in the constitution or franchise or internal measures within the scope of local resources could have prevented. In spite of the social unrest however we found everywhere a striking loyalty to the British Crown and connection, and discontents are laid at the door of Colonial Office administration. This is perhaps a satisfactory fiction and reminds one of the tendency in many religions to divide phenomena between the opposite responsibilities of good and evil spirits, Downing Street here taking the diabolical part.

Although we have recommended considerable constitutional changes, we could not feel that the immediate grant of complete self-government based on universal suffrage, or the political federation of the whole of the scattered area would really touch the present difficulties. Unification of services wherever possible would clearly be of advantage, and we have recommended a practical test of how far federation can surmount the geographical difficulties in these widely dispersed communities by extending the federal system of the Leeward Islands so as to include the Windward group as well (Dominica, St. Lucia, St. Vincent, Grenada). Communications would certainly have to be transformed before any comprehensive federation for the

whole area from British Honduras to British Guiana could become possible, and the islands are staffed so economically that except for headquarter establishments it is doubtful whether any retrenchment could thus be achieved. It may prove easier in the long run to bring about closer union by the Comptroller of the Welfare Fund using his organization to improve the conditions in the more backward Colonies in preference to taking from the larger and richer units some of the autonomy which they so greatly value.

The account which I have given may perhaps seem rather gloomy, but I felt that you expected an unvarnished account of what we saw in the West Indies and the recommendations which we have made for improvements have already been published. If education can bring an understanding of the economics of population and production, the West Indies should be able to work out their own salvation.

DISCUSSION

Before the paper the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: It is hardly necessary for me to introduce Lord Moyne to you. You all know of the voyages he has made in his yacht and the objects he has brought home, including even dragons. This paper is a natural outcome of his visit to the West Indies as Chairman of the Royal Commission which recently examined the economic condition of the islands and has since presented a valuable report to His Majesty's Government. The main recommendations having now been accepted by the Government, we were free to ask Lord Moyne to give us a general sketch of his impressions of the British West Indies as he saw them last year.

Lord Moyne then read the paper printed above.

The PRESIDENT: As there are no questions, it only remains for me to ask you to thank Lord Moyne for the exceedingly interesting discourse he has given us.

RELIC GLACIAL FORMS ON THE WESTERN SEABOARD OF GRAHAM LAND

THE REVEREND W. L. S. FLEMING

IN the course of the British Graham Land Expedition 1934–37, I had the opportunity of making a study of the glacial features of a long stretch of coast-line in West Antarctica. I had hoped to have completed a report on these observations and to have submitted it at the end of this year for publication by the British Museum as one of the series of the Expedition's scientific reports. Owing to the war, the preparation of the report has been abruptly cut short, and the following paper has been hurriedly put together as a brief preliminary discussion of one significant problem involved.

Fringing glaciers. Throughout the whole length of the western coast of Graham Land the mountains rise steeply from the sea to heights which in many areas are 6000–8000 feet above sea-level. Between the base of the mountain cliffs and the shore is a belt of low-lying glacial ice, truncated on its seaward side by ice-cliffs. The name "fringing glacier" is here given to this ice form. These glaciers were termed "Piedmont glaciers" by Gourdon, but since that term has already been used to describe glaciers of different morphology and origin, its use here is obviously misleading. Holtedahl coined the term "strandflat glacier" for this type, as he was convinced that such glaciers sculptured as strandflats the platforms on which they evidently rest. Even though there is much to support Holtedahl's contention, it seems wise to follow the normal usage in glacier nomenclature and adopt a descriptive rather than a genetic designation.

North of Adelaide Island fringing glaciers form an uninterrupted narrow line of ice, save at certain of the more prominent headlands, where the rock cliffs plunge straight down to the sea. The cliffed front of these glaciers rises like a wall, so that it is difficult to find suitable places for a landing on this coast. South of Adelaide Island, in the branching fjords of Marguerite Bay, fringing glaciers are commonly developed on south and east shores, but are rarely to be seen on those which face north and west. The ice-cliffs in which these glaciers terminate may be as little as 15 feet or as much as 200 feet in height, but in most places they range between 80 and 100 feet and are remarkable for their constancy of height. The width of the ice-brim or the length of the ice in its direction of flow measured from mountain foot to cliffs is very variable, ranging from a few yards to several miles; but the height of the terminal cliffs bears no evident relationship to the width of the ice cover (Plate 4). Thus the thickness of the ice does not vary with the extent of its gathering ground, or the length of the glacier in its direction of flow. The gradient of the ice surface is generally a quite gentle seaward slope which, in most places, increases where the glacier rises to meet the cliffs of the headrock wall. In places a bergschrund is exposed in summer time, but this is by no means universal and never of any great size.

The position of the cliffed front of these glaciers generally coincides with the boundary between sea and bedrock (Plate 4), and if all the ice were removed, the shore-line would not be greatly altered. The ice stratification, as

seen in the frontal cliffs, is always clearly marked and is, in general, parallel to the almost horizontal ice surface. Where the fringing brim of ice is narrow and lies close in front of an active scree fan, scree material is in some cases seen to be incorporated in the lower bands of the ice. Elsewhere however, even at the base of the ice, there is usually very little included debris, and often none which can be seen from a boat a few yards off shore. The surface of the fringing glaciers is crevassed near the seaward face, the crevasses being aligned parallel to the shore and being progressively wider towards the sea. Throughout the year calving takes place along most stretches of the frontal cliffs, but in all the cases when calving was observed, the ice appeared to break away only from the top third of the cliff face. The calving ice breaks off along the crevasses parallel to the shore and also along smaller fissures. Both crevasses and fissures die out downwards so that the ice breaks away in wedge-shaped masses.

If one follows the fringing glaciers along the shore of any one bay, the width of the ice-brim in general becomes narrower towards the headlands and increases towards the backs of the bays. The fringing glaciers merge laterally with the distal portions of the valley glaciers, as these emerge from the mountains. The larger valley glaciers are sufficient in size and velocity to maintain their own characteristic movement and to constitute their own distinctive ice-streams from their valleys to the floating ice-tongues in which they terminate.

Whilst fringing glaciers are normal throughout almost the entire extent of the coast north of Adelaide Island, south of this island almost all north and west facing coasts are free from ice (Plate 2) except where valley glaciers emerge from the mountains and reach the sea. Here in place of fringing glaciers there is normally a beach shore. Behind the shore are a series of raised beaches disposed in recognizable though sometimes ill-defined terraces, the highest of which is approximately 80 feet above sea-level. On south and east facing shores however the glacierization presents no differences from that of the coasts farther north, typical fringing glaciers being present. Cape Calmette is a good example (Plate 3).

It is strange that Gourdon,[1] the geologist of Charcot's expeditions, did not concern himself with the origin of these glaciers, although he describes them under the rather misleading title of "Piedmont glaciers". It was left for Professor Holtedahl,[2] who visited some of the islands off the west coast of northern Graham Land, to suggest the origin of these glaciers, and to draw attention to their geomorphic significance. He described them as originating at the foot of a normal concave mountain slope leading down to the sea. According to his conception, the ice-foot provides a foothold for the first mass of snow. Nivation erosion begins and the headwall is progressively etched back by normal processes of freeze and thaw, concentrated especially along the inner edge of the ice. There are good reasons however against such an explanation of fringing glaciers. At present they lie under the snow-line, which means that they are not actively growing by annual increments of solid pre-

[1] E. Gourdon, 'Géographie physique, glaciologie, pétrographie.' Exp. Antarct. Française 1903–1905. Paris, 1908.

[2] Olaf Holtedahl, 'On the geology, and physiography of some Antarctic and sub-Antarctic Islands.' Oslo, 1929. See especially pp. 14–24.

cipitation. Even if one imagines these glaciers to have originated in a period when there was a greatly increased snow precipitation in relation to ablation, it is difficult to understand why the ice surface should not descend to the shore in a simple smooth slope. In that case in summer time a cliff would be left at most only a few feet high, where drift slopes descending to the winter sea-ice were breached during the open-water season. It might perhaps be argued that the amount of calving which takes place along the frontal ice-cliffs is evidence of sufficient seaward movement to give rise to cliffed fronts of the present height. But calving is almost entirely restricted to the upper parts of the ice-cliffs, and the small gradient of the glacier surface is evidence against glacial movement competent to produce a high cliffed front. Under any hypothesis these glaciers must have come into being when the snow-line was at sea-level. If in such circumstances it be assumed that the fringing glaciers accumulated in the way which Holtedahl supposed, and that the ice moved seawards at a sufficient velocity to produce a high cliffed front, then the absence of morainic material in the lower layers of the ice is difficult to explain. It is in fact evident that fringing glaciers, with the surface areas they now possess, could not attain a sufficient forward movement to give rise to their high cliffed fronts.

It may then be supposed that at the time of their development these glaciers formed part of a far more extensive sheet of ice. There is abundant evidence to support this view. First, such a conception accounts for the thickness of the ice, as shown at its cliffed seaward face, bearing no definite relationship to the width of the ice-brim between mountain foot and sea (*viz.* to the gathering ground). According to Holtedahl's hypothesis, one would expect to find the glaciers thinnest and their cliffed fronts lowest where the distance between the mountain cliffs and the sea was small. This is not the case (Plate 3). The second piece of evidence comes from Cape Berteaux. This headland is separated from the shore-line by a normal fringing glacier. On the south side of the headland the fringing glacier extends eastward to merge with a sheet of shelf-ice, about 650 square miles in area, locked within an embayment of the coast. This we called the Wordie Shelf Ice. The fringing glacier here clearly originated as the landward part of what had formerly been a wide stretch of shelf-ice, which had extended out to, and probably a considerable distance beyond, Cape Berteaux. By analogy, this method of formation would apply for all other fringing glaciers along this coast. Apart from the Wordie Shelf Ice, there are at least three other shelf-ice remnants still left along this coast: the shelf-ice filling King George VI Sound between Alexander I Land and the west coast of Graham Land; a triangular wedge of shelf-ice at the north-east corner of Adelaide Island (seen only from the air); and lastly, a small remnant of shelf-ice which lies locked at the head of the southern arm of Beascochea Bay. But in no case is the connection between fringing glacier and shelf-ice so clearly shown as along the coast south of Cape Berteaux. The fringing glaciers are to be regarded then as relics from the time when shelf-ice filled all the bays of the west coast and extended beyond the off-lying islands. A climate only slightly different from that which now prevails in this part of the Antarctic would permit the initiation and growth of such a sheet of shelf-ice.

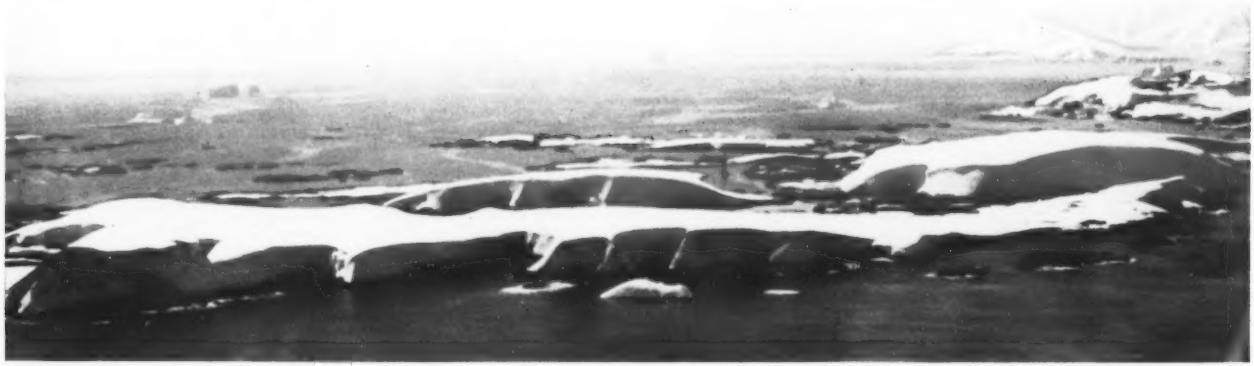
The fact that the fringing glaciers were built to their present thickness at a time when the surface merged on its seaward side with true shelf-ice raises the separate question as to whether these glaciers were competent to erode the rock platforms on which they rest. In this connection it must be remembered that the cliffed front of these glaciers rests on rock at sea-level. Holtedahl stressed this fact, and pointed out that if the fringing glaciers were completely removed, then between the mountain foot and the sea there would stretch a low, and perhaps irregular, rocky bench or platform. This he believed would resemble the rocky forelands of Norwegian and many Arctic coasts which lie between the high coastal mountains and the sea, and to which the name "strandflat" has been given.

The origin of strandflats has interested many writers. They have been attributed to marine, sub-aerial, and glacial processes of denudation, and, by most writers, to a combination of these modes of development, with one or other predominant. Nansen[1] ascribed the major work in the cutting of these platforms to the sea, which he thought would be specially favoured by freeze and thaw action along the coast. He ascribed to later glacial action only a modification in detail of the marine-cut platform. It is relevant to ask, in passing, whether the conditions postulated for freeze and thaw of sea-water along the coast would not, in fact, give rise to an ice-foot which would greatly retard marine erosion. There is however a more formidable argument which make Nansen's theory of the marine erosion of strandflats inapplicable to the platforms on which the fringing glaciers of Graham Land rest: these platforms are narrower or non-existent at headlands whose exposure to wave approach would render them most liable to marine erosion, and they become broader towards the back of the bays.

Ahlmann,[2] who discarded Nansen's theory for the formation of strandflats, regards sub-aerial denudation as the main process which formed the strandflats he had studied in Norway, North-East Land, and Spitsbergen. Like Nansen, Ahlmann concedes to glacial erosion only a minor rôle: that of sharpening the line of contact between the strandflat and the high land which borders it, and also some measure of the detailed sculpturing of the strandflat itself. But, even if Ahlmann's hypothesis be accepted to account for the strandflats of the north, it could not so readily be applied to Graham Land, where there is no evidence whatsoever of sub-aerial erosion having played a part in the dissection of the coastal topography. The angular pattern of the topography, and in particular the arrangement of the main glaciers, led Holtedahl to the opinion that these features may be due to glacial erosion without any preceding fluvial cycle. I have found no evidence to oppose this view.

The third hypothesis for the excavation of a strandflat, namely that glacial dissection is the dominant process,[3] is greatly strengthened by the fact that along the west Graham Land coast glaciers actually rest on rocky forelands of strandflat type. Holtedahl was so convinced that the formation of strandflats was there in process of development that he called the glaciers which rested on

[1] Fr. Nansen, 'The strandflat and isostasy.' Kristiania, 1922.
[2] H. W:son Ahlmann, *Geografiska Annaler* (1933), pp. 107–111.
[3] See also Olaf Holtedahl, *op. cit.*, pp. 146–168.



1. Ice cliffs on the southern shores of the whaleback island ice caps in the Argentine Islands, from the air

2. Looking north up Bigourdon Fjord: contrast in glacierization between the coast in the right foreground facing W.N.W. and that in the left background facing south-east

3. Fringing glacier on the south side of Cape Calmette

4. Narrow fringing glacier on the south side of Cape Trois Perez, resting on rock at sea level

them "strandflat glaciers." One main objection to Holtedahl's hypothesis was that it was hard to see how the glaciers could ever have attained the thickness and high-cliffed fronts which they actually assume. This offers no difficulties when one realizes that these glaciers form but the landward extension of a large sheet of shelf-ice which has since been broken up. Along the inner edge of such a sheet of ice the mountain sides would be etched back by the same processes which Lewis[1] has envisaged for the headwall sapping of a cirque, frost action being concentrated especially at the junction between ice and rock. The rock cliffs which lie at the back of the fringing glaciers are riven and shattered just like the headwalls of cirques, a fact which suggests a similar method of sculpture.

But supposing that the fringing glaciers were competent to cut the rock platforms on which they rest, there are still difficulties which must be faced. In the first place, if it be assumed that cirque headwall sapping was active for the development of these platforms, or if it be assumed that any process of glacial cutting had given rise to them (however large or small a share be ascribed to frost action at the headwall), then the eroded material must be carried off by the glaciers themselves. In fact there is practically no debris, even in the lowest layers of ice. Holtedahl recognized this difficulty, and was apparently able to set his mind at rest, because masses of englacial boulders are present at some places along the ice fronts. Moreover, since the sea washes the base of the ice-cliffs, observations are not easily made, so suggesting that there may actually be a considerable amount of debris in the ice, which is hidden from sight. Finally, glacial debris which emerges at, or just below, sea-level, might be incorporated in the adjacent winter sea-ice and carried out to sea the next summer and so escape observation.

These explanations do not seem satisfactory. In certain places I obtained close views of the fringing glaciers, and the cleanness of the ice from top to bottom was in most, though not in every place, a fact which could not be gainsaid. If these glaciers are eroding their platforms, where is the material which is being removed?

The second difficulty arises from the presence of the series of raised beaches, to which reference has already been made, on the north and east facing coasts in the region south of Adelaide Island. There can be little doubt that they are ordinary shore features indicating successive changes of sea-level from a height of 80 feet down to the present level. They may indicate the gradual raising of the land in isostatic response to the present recession of the ice. There is ample evidence that recession is generally taking place all along the coast. Now these beaches could not have been formed after the present development of the fringing glaciers. If the sea had stood 80 feet higher than it does now during a sufficient time to form distinct, though not very extensive, beaches on the ice-free shores of the southern sides of the bays and fjords, then at least some of the ice, if not all of it, which was exposed to the waves at or below that level on the opposite shores would have been calved away. As it is, the ice is still there. It is therefore clear that the beaches must have been formed before the present development of the fringing glaciers. Indeed, where the relationship of the beaches to the glaciers can be seen, the glaciers

[1] W. V. Lewis, *Geological Magazine*, 75 (1938) 249–65.

always appear to rest upon, or to have overridden the beaches. This complicates the theory of the glacial cutting of the rock platforms under the fringing glaciers. According to this theory, on the north side of any bay in the region under consideration, fringing glaciers are assumed to be excavating the rock platforms on which they rest: their cutting tool is headwall sapping, and excavated material is carried away by the ice moving in the general direction of the contiguous shelf-ice sheet. On the opposite or southern side of the same bay it has to be imagined that the ice was sufficiently inactive or protective not even to destroy the terraced arrangement of unconsolidated beach material beneath it. It is difficult to conceive ice wearing down resistant rocks on one side of a bay, and protecting unconsolidated sediments on the other.

One suggestion which might be put forward is that the platforms were cut in a previous cycle of shelf-ice occupation of the bays, and that a period of glacial depletion had intervened to result in the complete disappearance of this shelf-ice, and of the bordering fringing glacier-ice, before a renewal of shelf-ice conditions had favoured the existing development of the fringing glaciers. Frequent periods of waxing or waning of the ice are to be expected during any glacial age, and there seems no *a priori* objection to introducing as many oscillations as will help to explain the facts. But the idea that these platforms were cut in a possible earlier shelf-ice cycle provides no clue as to how they were cut. Why, if they were cut in an earlier period by fringing glaciers when part of a shelf-ice sheet, were they not further eroded during the last shelf-ice cycle, when precisely the same conditions had been established and the same processes had become operative as in the present cycle? To shift the episode in which these platforms were cut to an earlier cycle is not of much help in understanding the conditions that accounted for their erosion.

Nevertheless these considerations do not justify the complete abandonment of the theory that the fringing glaciers have eroded the rock platforms on which they rest. It must be remembered that the reason for a marked dissimilarity in the glacierization of north and west facing shores from those which face south and east, in the region south of Adelaide Island, was probably quite as marked at the time when shelf-ice filled the bays as it is now. It is not too fanciful to suppose that during the occupation of the bays by shelf-ice, the ice either failed to cover the north and west facing shores, or was so thinned by ablation as to have little erosive effect on the beach material beneath it. The conditions might be compared with those which we actually saw on the western side of King George VI Sound. At the head of Ablation Bay, in latitude 70° 45′ S., the shelf-ice which fills King George VI Sound has been so thinned by ablation along the east shore of Alexander I Land as to reveal a normal tide-crack. Within a few hundred yards from this part of the shore, the ice surface rises to its normal level. At this particular place the shelf-ice is thinned from its normal thickness to a matter of a few inches within a remarkably short distance.

Island ice-caps. The same conditions which gave rise to the fringing glaciers of the western seaboard of Graham Land are responsible for the occurrence, north of Adelaide Island, of peculiar ice-caps on the smaller islands. Like the fringing glaciers, these local ice-caps could not have originated by snow accumulation within the gathering ground of the island shores. Island ice-

caps are well developed in the Argentine Islands. The surface of the ice rises in a gradual slope from the north to a simple domed summit situated near the southern end of each island (Plate 1). Along the south shore this cap of ice is truncated by cliffs sometimes as much as 140 feet in height. The cliffs are undermined by caves wherever the ice happens to bridge small bays of the rock shore. The orientation of these whale-back ice-hills is evidently related on the one hand to the direction of the dominant winds, which are approximately N.N.E., and on the other hand to exposure to the sun, the southerly cliffed face of the ice-hills being the side most shaded from the sun's rays. The dominant winds are commonly accompanied by relatively high temperatures, often over freezing-point; and drifting in winter and ablation facilitated by rain in summer are at their strongest during the northerly or north-easterly storms. It is clear that the islands lie wholly beneath the present snow-line. Glacial shrinkage is everywhere evident.[1] During the year when we were at the Argentine Islands there was a marked excess of ablation over precipitation, a fact borne out by comparing the amount of exposed rock seen at the end of the summer seasons of 1934–35 and 1935–36, and the even greater contrast seen at the end of 1936–37. During the summer months there was neither snow nor *névé* left at the surface of these hills, but old hard ice undergoing thaw. There seems no reason to suppose that the seasons when we were in this region were exceptional, though variations of the amount of ablation are naturally to be expected from year to year, and climatic cycles would presumably occur here, as in other parts of the world.

Amongst the island ice-caps of the Biscoe Islands, the shape of the ice cover clearly depended on the size of the islands. Three types may conveniently be distinguished: each of the largest islands, such as Nansen Island, is wholly covered by a carapace of ice in the form of a gently curved dome. The summit lies somewhat to the south of the centre of the island. The sweeping curve of the ice is abruptly truncated at the shore-line, though at some headlands, in place of the normal cliff, the ice falls off in a steep slope. Only close to the shore is the ice crevassed, the crevasses being orientated approximately parallel to the shore (Plate 5). There is an intermediate class of islands, $\frac{1}{4}$–1 mile in diameter, which is similar to the first type, except that a gradual streamlined slope leads from the northerly shore, and the summit of the ice-cap is more clearly seen to be eccentric, *i.e.* it lies closer to the southern end. Finally there are smaller islands like the Argentine Islands (Plate 1) where in summer time considerably more rock is exposed (the amount of ice-free rock depending on the shape of the island) and where the asymmetry of the ice covering is more pronounced (Plate 6). Only in rare instances is there an exception to this relationship between the size of the island and the shape of its ice cover. Exceptions could always be assigned to special local conditions.

The thickness and character of these island ice-caps conforms to the conception of a recent occupation of the coast by shelf-ice. The islands were,

[1] G. C. L. Bertram emphasized the increase in ablation produced by biological agencies. Once rocks are exposed, birds form colonies and their faeces provide a good environment for algae that burrow in or lie on the ice. Such factors however operate only after the glacial shrinkage has already begun from climatic causes.

until recently, covered by a sheet of ice continuous with the shelf-ice that surrounded them. Since the removal of the shelf-ice the influence of northerly gales accompanied by relatively high temperatures in summer time and by drifting in winter time, combined with the differential effects of thaw with respect to shade, have quickly altered the original cake-like ice-caps to an asymmetrical whale-back form. The asymmetry is of course more pronounced in the smaller island ice-caps.

The island ice-caps and the fringing glaciers of the western seaboard of Graham Land are unstable and ephemeral glacial features. The shelf-ice with which they formed a continuous sheet and to which they owed their development must have broken away from the coast quite recently. If the present climate continues, both these glacier forms will disappear completely within the space of a few years. The chance that this transitional and unstable stage of glaciation is found in this area at the present day may provide an important clue to the origin of strandflats on which the fringing glaciers rest. The existence of shelf-ice off the Arctic coasts, where strandflats occur, may have been an essential condition for the cutting of these low rock platforms by glacial erosion during the Pleistocene.

5. Asymmetry of small island ice cap in Mutton Cove. The cliff facing south is 60 feet high

6. Cliffed shores of the ice cap of one of the larger Biscoe Islands near Mutton Cove: crevassing of unstable cliff face and absence of debris in the lower layer of ice

1. Interior of a gold mine, about 1850 A.D., by Hiroshige II

THE EVIDENCE FOR ANCIENT MINING

C. E. N. BROMEHEAD

Meeting of the Society, 22 April 1940

THE history of ancient mining makes demands on many and varied branches of knowledge. Although flint was the material first sought for by means of mines and precious stones have been obtained in the same way, mining for metallic ores is by far the most important. The subsequent treatment of the ores is not strictly a part of mining, but it will be necessary here to refer to the ancients' knowledge of metallurgy in order to realize what, at any given period, was a useful ore: for example, wolframite, the source of tungsten, did not become an ore until the middle of the nineteenth century. The subject is thus one for cooperation: the explorer finds a new site, the archaeologist dates it, the geologist learns the nature of the material worked and its mode of occurrence, the metallurgist says what could be done with it and so on; alternatively the archaeologist discovers a metal weapon or ornament, and it may need a chain of experts to determine the nature of the material, its original source, the people who extracted it and the methods they employed; or the scholar and philologist may need help in interpreting correctly statements and descriptions in ancient writings. It is the object of the present paper to indicate some of the more interesting results already obtained and thereby to stimulate further cooperative research; some of the more obvious gaps in our knowledge are pointed out.

A picturesque and charming account of early mining is given in the Book of Job (xxviii, 1–11), written probably about 450 B.C. It had already been true for some 2000 years and was to remain so for roughly another 2000 until explosives and steam power revolutionized our subject; but it does not enter into great detail. We shall see that a real evolution of mining took place, but that many of the principles observed in the most up-to-date mines were already known and practised in ancient times. The most primitive examples found or known from ancient writings are not necessarily the oldest; in fact a mine of the present day in such backward areas as Central Africa may be less advanced than one in Europe or Egypt dating from a thousand years B.C. It must also be remembered that in many cases almost unlimited numbers of slaves, or prisoners, were available; consequently methods already known for saving labour or improving the conditions for the miners were not necessarily employed. For this reason a gold mine in Siberia is, or was recently, being worked in a manner resembling that described below from Ancient Egypt.

Flint

The earliest mineral to be mined was flint for the making of implements during the Stone Age. Definite mines, apart from open workings, are known in Belgium, France, Sweden, Portugal, and Sicily. In England we have mines at Grimes Graves and Massingham in Norfolk, Cissbury, Black Patch, Harrow Hill and others in Sussex, and Easton Down in Wiltshire, of which

the first are the most famous. It is almost certain that in every case they are of Neolithic date, but the question has been hotly debated.

At Grimes Graves the bed of flint sought for is known as the "floor stone." In the side of a glacially cut valley the beds have been distorted and the floor stone brought from a depth of 5 feet to within a few inches of the surface. From this outcrop it was followed by mining. The earlier shallow pits with no galleries were cut with bone picks, mostly from the long bones of ox (one is from a human femur); the marks found fit these picks. Mr. Leslie Armstrong, to whose researches most of our knowledge of Grimes Graves is due, attributed these workings to late Palaeolithic times. The Neolithic shafts reach as much as 35 feet in depth and are provided with galleries in which to follow the "floor stone," layers of inferior flint cut through in the shafts being ignored.

At Spiennes, shafts occur over an area of 6 acres; they are mostly 30–40 feet deep and 24–32 inches diameter. The chalk contains several layers of flint, of which the sixth from the top is best. When the fifth is reached in the shaft a chamber is formed $6\frac{1}{2}$–10 feet in diameter and 4–5 feet high, with the desired bed as a floor: in fact, a typical bell-pit. Then six or seven radiating galleries were driven which sometimes connect with those from neighbouring shafts. In making the shafts and galleries a variety of tools were used. At Obourg in Belgium only horn picks occur; a skeleton of a miner buried by a fall of roof held a single-handed pick. The works here were mostly opencast with occasional tunnels from one trench to the next. The flint is suitable for long knives and scrapers, but not for axes. One polished axe has been found, but the material is identified as coming from Spiennes. At Spiennes and at Champignolles flint axes were the usual tools, together with wedges, cut from horse metacarpals, for loosening the chalk. At Black Patch in Sussex tines of deer horns were used for this purpose: the wedge-holes can still be seen; the picks were mostly of deer horn. The numerous forms of flint and other stone implements, the objects known as "chalk-lamps," shells of contemporary mollusca, and other finds from flint mines are useful for dating purposes, but here it is sufficient to say that within the Stone Age flint mines were made resembling the bell-pits and galleries dug for coal in the north of England as late as the nineteenth century. In many cases, where stone implements are abundant, good material was available at the surface without mining, as for instance in Egypt, where pebbles were frequently used.

Gold

Gold was probably the first metal used by man; native gold is conspicuous and attractive in appearance. Moreover, large quantities have been obtained from alluvial deposits without real mining. Gold ornaments of Neolithic age have occasionally been found and in later periods gold is universal. Our first historical evidence is from Egypt. The earlier jewellery is of alluvial gold that had not been melted; it is below 17 carats and contains specks of platinum. Refined gold is not known before the Persian period, when cementation with salt became known. Great quantities were obtained, both as tribute and from workings in Egyptian territory, mostly among the mountains between the Nile and the Red Sea, and in the Sudan. In an inscription of about 1800 B.C.

at Abydos, Amenemnet II says "I forced the Nubian chiefs to wash gold." Placer workings have been found in the Bisharee desert and include cisterns for storing water. Job mentions (xxii, 24) the "Gold of Ophir among the stones of the brooks."

By about 2500 B.C. true mining was familiar; auriferous quartz veins were followed by shafts and adits and the material crushed with stone hammers for washing. The earliest known map in the world is a plan of a gold mine of the 19th Egyptian dynasty (1350–1205), probably near Hammamat, whence came the "black basalt" (usually a quartzite) used for statuary. The inscriptions at various points read "the mountains in which gold is washed; they are shown in this red colour [this seems to be a title and index], Mountains of Gold, Temple of Amon, house of gold workers, roads that lead to the sea."

The country rock is gneiss and schist with intrusions of greenstone, elvan, etc., cut by quartz veins, especially near the intrusions. The mines are always on the outcrop and follow the veins down. There are no cross-cuts from the wadi bottoms. The same mines were worked in Ptolemaic times, and described by Agatharchides, who visited them in 170 B.C., as follows:—"The hardest of the earth that contains the gold is exposed to a fierce fire, so that it cracks, and then they apply hand labour to it; the rock that is soft and can be reduced by a moderate effort is worked by thousands of the luckless creatures with the iron tools that are used ordinarily for cutting stone. The foreman, who distinguishes one sort of rock from the other instructs the workers in the whole business and assigns their tasks. Of those that are condemned to this disastrous life such as excel in strength of body pound the shining rock with iron hammers, applying not skill but sheer force to the work, and they drive galleries, though not in a straight line, but in the direction taken naturally by the glistening stone; these then, on account of the winding of these passages, live in darkness and carry around lamps attached to their foreheads." He then describes how children brought the ore to the surface and old men and women crushed and pounded it until it was as fine as flour.

Gold has been obtained in very ancient times from such a number of countries and so many localities that it would be tedious to enumerate them. The biblical Ophir was probably the Arabian coast of the Persian Gulf, and Havilah the Yemen. The gold of which such beautiful use was made in the early Mesopotamian civilizations may have come from the Persian mountains, but we know nothing of the workings.

Many of the rivers of Asia Minor and Greece were famous for their alluvial gold. A map of the Greek gold-fields has been prepared by Rickard. Alluvial gold was distinguished from reef gold—*χρυσοπλυσίον* from *χρυσωρυχεῖον*. Demastion, an important silver mining region in classical times, is the legendary source of the wealth of Midas (Strabo and Herodotus). Coins of Demastion of the first half of the fourth century B.C. show picks and a square ingot with carrying handles. Krenides, according to Diodorus, yielded 1000 talents of gold per annum to Philip of Macedon. The river Hebros in Thrace, mentioned by Pliny in a list of gold-bearing rivers, yielded a little gold in the sixteenth century A.D.

Copper

Of far more practical importance than gold, at any rate until the latter became a standard, is copper, and its tin-alloy, bronze. Copper was in use among the Sumerians probably as early as 5000 B.C. and was common by 3000. The later copper here contains both nickel and arsenic. A band of copper ores containing these elements runs through Anatolia, Armenia, and Azerbaijan; and well before 3000 B.C. there was an important metallurgical centre south of the Caucasus, a region with which, it will be remembered, the Greek legends associate the gift of fire. There is some evidence from pottery and the shapes of metal objects to connect this district with the Sumerian culture of Mesopotamia, but definite proof is lacking. In the earliest times of which we have any knowledge from the excavations at Kish and Ur there is however little likelihood of contact between the two regions; a copper deposit with traces of very early working has recently been discovered by one of the Anglo-Persian Oil Company's geologists at Jabal al Ma'adan. This ore agrees in analysis with the earliest specimens of copper, and the local names connect with the "Mountain of Magan" mentioned in tablets of about 2700 B.C. This, then, was probably the source of Sumerian copper down to the first Babylonian dynasty, but more information is desirable. Copper was worked in many parts of Egyptian territory from the third dynasty onwards, but the knowledge was later than and almost certainly derived from Sumeria. Many mines are known, but those most often quoted, in Sinai, were largely for other materials, copper being worked only for a short period.

In Europe, copper mines belonging to the Bronze Age are known in Austria, Germany, France, England, Ireland, Spain, Portugal, Greece, southern Russia, and above all in Tirol. Here the mines of Mitterburg were apparently worked from about 1600 B.C. in the Bronze Age continuously into the Hallstatt period of the Iron Age about 800 B.C. The occurrence of native copper in the valley of the Tisa may have led to the recognition of the ores. Many relics have been found and described and I take them as an example; my information is from Dr. Julius Andree's 'Bergbau in der Vorzeit' (Leipzig, 1922).

Both shafts and adits were driven and ventilation was provided by two or more shafts connecting with a single level; these were 1–2 metres in diameter. Access was gained by tree-stems with notches cut to form a ladder. Timbering was also used in the galleries, which are up to 100 metres in length. Where the walls were soft, they were revetted with moss and clay squeezed between the boards. In one or two cases stone-drifts have been cut to search for a vein that had been lost. Fire setting was used to split the hard rock, water being sometimes poured on the heated surface to hasten the action. Water was introduced, if necessary, by launders consisting of hollowed half tree-stems and by buckets. The tools were of bronze and were cast. Illumination was by torches. Bronze hammers were used to crush the ore in the mine; it was sized with wooden riddles with hazel-twig meshes and brought up in leather bags and wooden troughs. A windlass with three spokes has been found.

On the surface, the ore was pounded with small hammer stones, but not, apparently, ground; then panned in two-handled vans. The smelting furnaces

were built square with walls of clay and an open top. Alternate layers of ore and wood fuel were laid; the slag was run from a hole in the front wall. One of the resulting cakes of smelted copper has been found.

The ores worked in every case of which we know are either the oxidized layers near the surface of sulphide deposits, or the green and blue carbonates and silicates. These can all be reduced to the metallic state by simple smelting in a furnace such as that described from Mitterburg; the type is very ancient, though the one found there probably belongs to the seventh century A.D. Petrie has shown that Egyptian blue glaze, a lime-copper silicate going back to very early times, was made in a primitive furnace, but requires a constant temperature of 860° C. for twenty-four hours. That such control could be obtained with straw fuel indicates astonishing skill in the workers. On the other hand, sulphide ores need a double treatment, calcining to remove the sulphur and then smelting of the roasted product. This process was probably unknown before the days of the Roman Empire. The first actual mention of ores is by Theophrastus (372–288 B.C.), who described green and blue ores from Cyprus.

The copper ores of Cyprus were in full use and were supplying Egypt during the 18th dynasty, which began in 1587 B.C. A large tribute was sent from there to Thothmes III, 1500 B.C. The mines were famous in Homeric times, and huge mounds of mining debris and of slag exist, but details are still lacking. It has been recently announced that ancient copper workings have been cut into by a mining company and are being investigated by the Cyprus Department of Antiquities. The smelting works can be dated 1350–1300 B.C. (see article in *Illustrated London News*, 29 February 1940). No doubt much new information about ancient mining will be obtained in Cyprus.

Professor Davies has described some copper mines of the La Tène period at Burgas in Bulgaria: they include an opencast 50 metres long by 40 metres deep and rows of shafts 8–15 metres apart. The vein of malachite, yielding from a picked sample over 9 per cent. of copper, was completely worked by fire setting.

In Britain ancient copper workings are known in several parts of Wales and at Alderley Edge.

Tin

Except in Egypt, where it remained the usual metal for tools, etc., until Ptolemaic times, copper was soon replaced by bronze. I have not come across any useful descriptions of ancient tin mines, but by tracing out known occurrences and from literary allusions we can get much interesting information as to the sources used. Detailed analyses of the ores and of the metal for such impurities as lead, antimony, arsenic, and nickel, throw light much on ancient trade routes. As an example we may take what Professor Gordon Childe has called the Danube Thoroughfare, the great route from the Mediterranean lands to those draining northwards.

The loess deposits formed attractive ground for settlement, with the rivers for communication and fishing, and so led settlers into the mineralized regions with many important gold and copper mines, including those of Mitterburg just described. By continuing into the valley of the Elbe the tin districts of

Bohemia and Saxony are reached. The cassiterite occurs mostly near the junction of the granite and slates on either side of the Erzgebirge, in much the same way as in Cornwall. The route thus developed became one of the chief avenues by which amber was brought from the Baltic to the classical world. This trade was certainly in existence during the Bronze Age.

The tin of Spain, Brittany, and Cornwall was traded to the eastern Mediterranean by the Phoenicians certainly as early as 1500 B.C., probably from Spain before 1900 when the second city of Hissarlik was destroyed; but bronze is known even earlier in Mesopotamia. A metal bowl from the grave of Queen Shubad at Ur, about 3100 B.C., contains 8·5 per cent. tin. Not many years ago tin was found in the Altai region of Central Asia; ancient workings contain bronze tools; but we may have to wait a long time before the discovery can be fitted into a general historical study of our subject.

The Romans worked tin at Vaudry (Hte. Vienne), first by a large opencast and subsequently by galleries. They also continued the Spanish mines, which had been largely worked by the Carthaginians. The history of British tin is discussed below.

Salt

In the early Iron Age we are fortunate in having a group of mines which have been fully explored at the type locality for their period, Hallstatt. But they are salt mines, not iron mines. There is no need to dwell upon the necessity for a supply of salt; the uses at that period were the obvious ones, though later much salt from this district was used in the cementation of metallic ores, as described by Pliny. The salt occurs in beds in Triassic rocks and is still worked; there are also masses of exceedingly tough anhydrite (sulphate of lime), which are now dynamited. The early miners went round these.

Sloping shafts were driven, entering the ground at angles from 25 to 60 degrees from the horizontal. Timbering was used, but there is evidence that the climate was drier than to-day and the danger from water less. When a rich mass of salt was encountered, galleries were driven in various directions according to the yield. The greatest distances worked were 390 metres horizontally from adit mouth and 100 metres below surface. Large chambers were opened in the salt; one 12 metres broad and averaging over 1 metre in height had been carefully timbered, though when found subsidence had flattened it out.

The tools were bronze picks and chisels, some of which still had their wooden hafts. Wooden mallets were used for pounding the salt, which was then shovelled into leather sacks to be taken out of the mine and carried to the valley. Bundles of twigs were used for torches; lamps have not been found. A platter of maple wood shows that the men had meals below. The conditions favour the preservation of leather, and a sack has been found complete with straps for carrying, probably round the forehead; also miners' clothing, cap and shoes with laces, not to mention the skeleton of the miner who has been crushed by a fall of roof.

The Vienna Museum handbook on the subject, from which my information is taken, draws attention to some unsettled problems. We know nothing of any system of ventilation, which seems essential; the waste material has

mostly vanished; the usage of tools must have been enormous: nowadays a miner there uses ten steel picks in an eight-hour shift. The foundries where the bronze picks were cast or recast have not been found.

The silver-lead mines of Laurium

Coming now to classical Greece we find what are probably the most famous mines in the world, the silver mines of Laurium or *Λαῦρειον* at the southern end of the Athenian peninsula. It is far more true that the battle of Salamis was won in the mines of Laurium than that Waterloo was won on the playing fields of Eton. The mines were first worked by Mycenean peoples and then abandoned. Athenian working began about 600 B.C. Silver was scarce in Solon's time (638–598), but by 500 B.C. royalties on Laurium appear in the Athenian budget. The mineral worked was mostly galena, but the silver content was such that the mines were always spoken of as silver mines; it runs from 30 to 300 oz. troy per ton, averaging about 60 oz. From the middle of the last century the area was worked by a French company, mainly for zinc, and the French School of Archaeology at Athens has been enabled to make a complete study of the mines, which till then had been untouched since about A.D. 100.

Geologically the ground is made up of three beds of limestone or marble separated by two of mica-schist, sometimes traversed by dykes of granite and gabbro. Galena occurs throughout, but is concentrated at the junctions, more especially at the tops of the two lower beds of limestone, where it is overlain by schist. The ascending solutions which brought the ores had difficulty in piercing the schists and were concentrated at the planes of contact. The top limestone is the highest bed of the district.

The lead is accompanied by zinc and iron. At the outcrop of the upper contact the galena, blende, and pyrites give place to cerussite, calamine, and haematite. The red colour due to the last makes the outcrop a conspicuous feature; probably it was worked for iron at an early date and later was used for the manufacture of tools to work the argentiferous galena. The earliest remains are opencast with short adits; later more than 2000 shafts were sunk, connected by galleries. It is noteworthy that there is practically no outcrop of the lower and richer contact-zone. Its discovery and working were a matter for inductive geology. The shafts are exceedingly regular; they are rectangular and usually 1·9 by 1·3 metres. The centre line is very accurately vertical, but about every 10 metres of depth the horizontal section is turned through an angle of 8 or 10 degrees, so that the rectangle at the bottom may be at right angles to that at the top. These stages seem to depend on the method of access; a succession of poles or tree trunks with steps cut in them, fixed to the sides, leaving the middle free for hoisting ore, etc., by a rope and pulley. Parts of the wheels for these have been found and the markings of the axles at the top. The deepest shaft is 117·6 metres, the limiting depth being the water-table approximately at sea-level.

At the contact-zones galleries were driven, normally 40 inches high by 30 inches broad, more or less following ore shoots, but betraying also a definite plan. Shafts were sunk in pairs and parallel galleries driven, with frequent cross-cuts to aid ventilation. In the map of the Demoliaki mines main galleries

from the Louis Joseph and Jupiter shafts run roughly up a dip-slope to Nos. 3 and 4, with a rise of mine-level and surface-level of 50–60 metres, again aiding ventilation. No doubt the parallel galleries also served as inbye and outbye roads. Where rich bodies of ore were found they were stoped either overhand or underhand according to circumstance; branch galleries were cut leading out of the main road at the necessary slope to reach the desired point. From some of the stopes as much as 100,000 tons have been taken. In these pillar and stall work was used, the poorer ore being left as pillars. Sometimes all was taken and pillars to support the roof were built up from waste. Under Lycurgus in 339 B.C. a law was passed against the removal of pillars, some of which are 30 feet high. But Strabo says that in his time (30 B.C.) the slag heaps were being re-smelted and the stope-fillings robbed.

Many of the galleries show grooves in the sides, where doors could be temporarily or permanently fitted to direct the current of air; abandoned galleries had built-up stoppings. In some cases the draught was increased by lighting fires. A sloping shaft was sunk to intercept a vertical working shaft. Just before the normal junction a horizontal cut was made, and on this level platform the fire was placed. Some of the sloping branch-shafts are cut in steps all the way. Probably fanning with cloths was also used; Pliny mentions it as a usual custom.

The work was done with wrought-iron tools, hammers of approximately Geological Survey pattern and picks with wooden handles, chisels, and wedges. Each miner had his lamp, and niches were cut in which to place those used in the approaches to the face. It is calculated that in shaft-sinking a miner averaged 15 feet per month. Timbering was seldom necessary, but remains show well-cut tenon and mortice joints between props and lintels. An immense amount of wood was however used for fuel at the smelting works on the surface. Laurium was originally well wooded, but by Strabo's time, as now, it was bare and arid. In fact we know that timber was imported in the fourth century B.C.

Professor Gowland has drawn attention to the close similarity between ancient methods and those in use till the middle of the nineteenth century in Japan. A delightful colour-print by Hiroshige II, published about 1850, shows the interior of a gold mine. Almost every feature, the step-ladders, miners' picks and lamps, etc., can be matched exactly in the Laurium mines.

The mineral left the mine in comparatively small pieces, but on the surface was put through stamps and mills. The resultant powder however contained not only galena but also proportions, varying with the locality, of quartz, blende, pyrites, fluorspar, iron ores, etc., and was now washed. The washing tables were of various sizes and angle of slope. One measured is 28 feet long, another 70 feet by 40 feet over all. They are constructed of masonry faced with concrete and a thin layer of fine cement. The water reservoir has conical openings, from which strong jets played on the mineral below. The heaviest portion collected almost at once in a shallow channel, the rest was sorted by gravity over a long wide surface, slightly inclined. By an ingenious arrangement of channels the water was collected in a sump at one corner just below the reservoir and was bailed back for re-use. The supply of water was one of the difficulties. Innumerable cisterns were constructed to conserve all the

rain-water falling during the winter months; each had a cover of planks to reduce evaporation.

Not much is known of the furnaces in which the cleaned galena was smelted; they appear to have been circular, 1 metre in diameter, built of trachyte or schist lined with clay. An artificial blast was supplied, and a clay tuyère has been found. There is some evidence that the limestone and fluorspar were used as fluxes. In this process only about 60 per cent. of the metal was recovered.

A pig of lead has been found containing 19 grammes of silver in 100 kilogrammes of lead, but it was the silver that was specially desired. The metal was therefore cupelled in vessels of clay or bone-ash; one of clay that has been found undamaged is so small as to suggest that it was an assay cupell, not one from the ordinary works. The buttons of silver that remained were extraordinarily pure. The Athenian coins, often referred to as Laurium owls (they had a head of Athena on the obverse and an owl on the reverse), contain 98·5 per cent. silver. And further, not more than 10 per cent. of the silver remains in the litharge. Incidentally, this word for lead oxide is Greek, *Λιθαργυρος*=silver stone, that is the stone produced in making silver, not silver-ore. Such excellent results show that the Athenians were skilled metallurgists; the bad results in smelting may have been due, not to lack of knowledge but to a desire to get the cream quickly and not bother about the milk.

The processes so clearly illustrated at Laurium go back to very ancient times. In Europe silver ornaments are common in the La Tène II period. In Asia Minor the Hittites worked it: the galena of Karahissar yields as much as 600 oz. per ton. It was probably this source that rendered the metal "nothing accounted of" by King Solomon. At Susa silver is mentioned on a tablet attributed to 4500 B.C. In Egypt in early times it was known as "white gold" and was more precious than the yellow. In the 18th dynasty it became common and second to gold, probably because conquest rendered accessible the mines in northern Syria formerly worked by the Hittites. The oldest lead known is from Hissarlik (Troy), 3000–2500 B.C., but is now shapeless lumps: a figurine dates from about 2000. Much remains to be learnt concerning the sources of the ores and the methods of working.

Iron

It is strange that the history of the most important metal, iron, is but little known. The earliest usage is the subject of controversy amongst archaeologists. Personally I think there is little doubt that it was meteoric. In many cases the presence of a considerable percentage of nickel proves it to be so : at Ur a specimen found by Woolley and dated about 3100 B.C. has been shown by Desch to contain 10·9 per cent. There is no evidence of iron being common until the reign of Sargon, 722 B.C. In Egypt it was rare and precious to Tutankhamen about 1350, and not common before 950; the earlier specimens are aptly termed "Sporadic Iron" by Petrie. The earliest group of iron tools was found at Thebes and is dated 666. Iron slag occurs at Meroe about 700. In the Aegean the earliest iron at Knossos is Middle Minoan about 1800; but even in Homeric times a lump of iron was a valuable present.

Iron ore on the contrary is everywhere abundant. In Western Sinai the

Geological Survey actually found heaps of excellent haematite at the mouths of Egyptian copper mines, evidently rejected as useless. For the rare objects of iron in early times an unusual source must be found. Again one thinks of meteoric iron, and it is noticeable that in the old world meteorites are very rare as compared with the new; the obvious reason is that they have been carefully collected for use, leaving few to be collected for museums.

Much has been written about the connection of early names for iron with those for the sky, an indisputable fact. But some philologists argue that the earliest names of all show no such connection. The logical deduction is not that the iron used was not meteoric, but that it was not then known to be so. That meteors had fallen from the sky was naturally a later and lucky discovery. Quite recently the cuneiform and Hebrew words for iron have been traced back to mean "stone from heaven": in the Bible the root of the word is found in the name Perrizites, the iron-workers associated in Genesis with the Hittites.

Again the earliest piece of Egyptian iron, found in the Great Pyramid in conditions strongly suggestive of a contemporary date, about 2900 B.C., does not contain nickel. But Flinders Petrie has found in Sinai a rich bed of haematite on which a sill of basalt has been intruded. Metallic iron may well have been formed in pockets, but is not yet known in actual occurrence. During 1933 some evidence turned up which suggested that iron was smelted from the ore, probably in the Caucasus region, somewhere round 3000 B.C. Frankfurt and Desch suggest that the art was again lost for 1500 years.

The general manufacture of iron seems to have begun about 1300 B.C. with the Hittites. In 1280 Rameses II of Egypt wrote to the Hittite king asking for some iron. The king could only send one dagger, but promised more when they had been made. Clearly the manufacture was so new that no stores were in hand. In the days of King Saul of Israel the Philistines had a local monopoly of iron-working, and the metal was not in common use till the time of Amos (760 B.C.). At Gerar Petrie has traced the remains of furnaces to 1200 and of mines a little earlier. Other early centres were around the south-eastern shore of the Black Sea, at Chalybes near the head of the Euphrates, whence comes the Greek name used by geologists in the form "chalybite," and in Kurdistan. The earliest mine of which we have any details was at Velem in Western Hungary and was excavated in 1928; it is of early Hallstatt date, say 1100–800 B.C., but the region had been an important mining centre for a long time, chiefly for copper and antimony, the latter being an excellent substitute for tin in the manufacture of bronze; ingots of antimony-bronze of late Bronze Age have been found here. The original opencast was 40 feet in diameter and was explored fully to a depth of 18 feet; but the explorers consider that there must be a shaft to 200 feet. Bronze and iron tools were used, and stone hammers for crushing the ore, which was then washed in the valley below. Both bronze and iron furnaces were found, the latter with two blast-pipes as needing the higher temperature. The ore was siderite, reduced by roasting with charcoal, leaving a solid bloom of iron which was then wrought into the tools and ornaments which characterize the Hallstatt Period. In the La Tène Period which followed, iron was being made on the north-west of Lake Neuchatel and in the Jura. In Jutland lumps of iron

scoriae and a bloomery have been found under Iron Age tumuli. As often, the ore was a superficial limonite pan. Such works must have been common all over Europe, but their preservation under a dateable deposit is a stroke of luck.

Iron is first known in Italy at the close of the twelfth century B.C. The ores of Tuscany and later of Elba attracted first the Villanovans and then the Etruscans (700–264 B.C.). The latter brought over much Elban ore to be smelted at Populonia on the mainland. Their wealth and success were largely due to their skill in working the metal. Aristotle about 300 B.C. mentions the iron of Elba and of the Black Sea region.

Roman ironworks can frequently be identified, but are seldom of much interest. A well-preserved furnace has been found at Ghelar (Gyalár) in Transylvania. The exact date is doubtful; the type was in use from very early times till the Middle Ages in Europe. A model of this furnace in the Science Museum is merely described as at least 1000 years old. A very similar furnace is in use now in the Sudan and in Central Africa. In the more primitive types the prevailing wind was the only blast. Bellows came later and were similar to those shown in a model in the Science Museum of a Sudanese forge for working up the bloom of iron into useful forms. In many cases a certain amount of steel would be produced from the action of the charcoal. As evidence of the good results obtained I may quote Pliny, who says that in his time an iron chain used by Alexander the Great for bridging the Euphrates still existed; those links which had been renewed were a prey to rust, from which the original links were free. In the Central Jura Davies makes the interesting observation that the distribution of Roman iron works depends on that of refractory clays for making the furnaces, rather than on that of the ore; Sheffield affords a parallel. He also found definite evidence that broken limestone was used as a flux.

Roman mines

Mines of the Roman period occur frequently all over the area of the Empire, but in most cases they were worked by conquered natives and the products taken as tribute. One district only need be considered, as it shows many advances in the methods and scope of the mining. Gold, silver, copper, lead, and iron were worked in Spain from very early times. It was the Tarshish of the Bible whence the Phoenicians brought silver, iron, tin, and lead according to Ezekiel. Later the silver mines of the Carthaginians supplied Hannibal and were the Roman spoil of the second Punic War. Though the most famous mine, the Rio Tinto, is now worked for copper, it was mostly argentiferous galena in the zone of oxidization that was worked by the Romans; the treatment was much the same as at Laurium, but Polybius says that the grinding, sieving, and washing were repeated five times.

The deepest shafts are as much as 650 feet deep, the widest 10 feet in diameter, but those in the Rio Tinto are $2\frac{1}{2}$–3 feet. These have footholds cut, and no ladders were used; but access for the miners was mostly by adits, the shafts serving for ventilation and winding, so that they seldom had to be climbed by a man. The adits were cut wide at the top and narrow below to allow a burdened man to walk with the minimum of excavation. One has

been found 2000 yards long. The cutting was done with iron tools of which many have been found. In addition to the relics and to several detailed descriptions in contemporary literature we have portraits of the miners in the Linares relief. The foreman carries a pair of tongs and what may be a bell, the first miner his hammer-pick, the second his lamp.

The chief interest however of the Spanish and Portuguese mines is the rich evidence of the means adopted to combat the metal miners' chief enemy, water. The first method is by hand baling. Pliny tells us that a mountain which supplied Hannibal with 300 lb. weight of silver per day had been excavated for a distance of 1500 paces. Throughout this distance there are water-bearers standing day and night baling out the water in turns, regulated by the light of lamps and so forming a great river. This simple means was in use till 100 years ago in Japan.

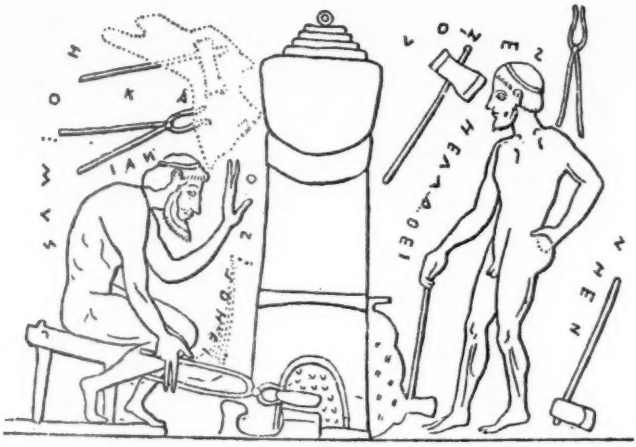
In some Roman mines in Portugal the adits are 5 metres high by 5 metres broad; against one wall is a narrow channel for water a further 5 metres deep. Every here and there is a chamber of 10 metres by 10 metres. In the centre of each is a large granite block round which runs a circular track worn by animals. The machine used is known as a chain of pots. Transmission of power by shafts and gear wheels is described by Ctesibias of Alexandria about 250 B.C. The remains found in Spanish mines suggest that a lift of 100 feet at greatest could be obtained. It is said that such machines were used to raise water for the hanging gardens of Babylon; the total lift was about 300 feet, possibly in several stages.

Again a great number of water-wheels have been found. In the San Domingos mine not far from Rio Tinto there was a series of nine wheels, $14\frac{1}{2}$ feet diameter, working in a gallery inclined at 40 degrees. These are most easily described as overshot water-wheels turned backwards by slaves. Yet another method of raising water was by the Archimedean screw. Archimedes is said not to have invented it, but to have seen it in use in Egypt about 220 B.C. In the Sudan it is in use to-day. It was known to the Romans as a *cochlea* or water-snail and a fine example was met with in the Centinello mine near Linares. In his book 'Man and Metals' Rickard has a restoration-drawing of this; he only shows one of the lugs which served for turning it, in place of the handle of the modern portable machine. These lugs were turned as a treadmill by the feet of a slave who held on to a fixed bar. A terra-cotta figurine from Alexandria, of the Ptolemaic period, now in the British Museum shows this fairly clearly. Its interpretation has been aided by a wall-painting recently discovered at Pompeii. The water brought from the mines was not run to waste, but served the concentrating tables. In some cases lengthy aqueducts were constructed for this purpose.

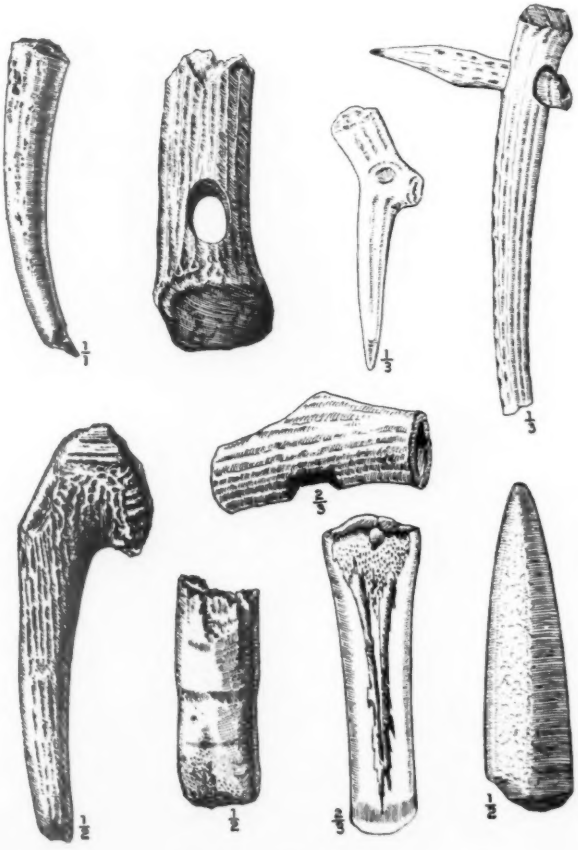
A number of bronze tablets found near the mines record the Roman mining laws. The subject is hardly within the scope of this paper, but it is worth noting that there are full regulations for the baths, which were well supplied with hot water. The first British legislation concerning pit-head baths is dated A.D. 1911.

The tin trade in Britain

It has been pointed out that, on a map of the Roman Empire, all the salient parts and late additions are mining areas. Britanny supplied tin and copper,



2. Iron furnace shown on an old Greek vase



3. Neolithic mining instruments

4. Fire-setting in a mine, about 1550 A.D.

5. Miner depicted in an early Christian monument

Spain and Portugal silver, lead, and copper. In Mauretania there were large workings for iron as well as copper; the exhaustion of the Egyptian gold and emerald mines in the Eastern Desert necessitated a slight southward extension of the frontier. Armenia was the cradle of metal working. Dacia included many mines for copper, gold, tin, and salt; the Black Forest, iron mines. Many reasons have been given for the Roman conquest of Britain. No doubt one was political; Caesar says that the Britons aided the Gauls with their treasure, in which the country abounded. Of commercial products we may ignore oysters and pearls. The principal products of Britain were cattle, slaves, and hunting dogs, and the metals gold, silver, and iron. In some respects this list, quoted from Strabo, is surprising: it includes gold and silver, the quantities of which actually obtained in Britain can never have been great. It does not include tin or lead, whereas the tin of Cornwall undoubtedly reached the Mediterranean many centuries earlier, and lead-mining was to become the most important industry of Roman Britain.

Pliny mentions the great abundance of lead, contrasting Britain where it was found close to the surface with Spain where it was won from depths with much labour. Lead was certainly exported from Britain by the Romans within six years of the conquest in A.D. 43. We cannot doubt that its existence was well known to them previously or that it was one of their main objectives. Strabo may have omitted it from his list, which was of exports to Gaul, because there was no great demand for it among hardly civilized people; the Romans on the contrary, with their elaborate water-supply systems, used this metal in great quantity. It is probably implied in the mention of silver. As we have already seen at Laurium and elsewhere, almost all the ancient production of silver was from the cupellation of argentiferous galena. Though there was early in the present century one mine in Cornwall working a silver ore, Perran, near Marazion, practically all the British output of silver must have been from lead: it cannot have been great as the proportion is nearly everywhere small. Its existence was probably assumed from a knowledge of abundant galena. The gold mentioned may have been of Irish origin. Irish gold was traded to great distances even in the Bronze Age; only one Roman gold mine, that at Gogofau, Carmarthenshire, is known.

Our knowledge of the working of metals in Britain both by the Romans and in earlier times is fairly complete; lead-working is well known, more from the finding of stamped pigs of metal than from actual mines, most of which have been destroyed by subsequent workings; ironworks in the Weald have been studied by Straker and others. Although, as far as the present writer is aware, no general account of early mining in this country has been published, it would necessarily be a compilation from published material, and little more than additional details can be expected in the future. One branch of the subject alone seems to call for a new discussion, both on account of its general interest and also to indicate the gaps that may yet be filled by research.

The absence of any mention of tin in Strabo's list may be due to production having ceased. The methods employed in more ancient times by the natives must have been very crude; no attempt at actual mining was made, and the easily won alluvial or stream tin may have been exhausted until improved methods of recovery were introduced. On the other hand, it may be merely

that the naval defeat inflicted by Caesar on the Veneti in the bay of Quiberon stopped the normal export channel.

There is plenty of evidence for the working of tin in Cornwall well back in the Bronze Age. At Carnon in a tin-bearing stratum in the river deposits a horn pick was discovered. It was in two parts; the beam was pierced just above the burr, the tines removed, and a dressed tine inserted and, presumably, fastened by a cord. A similar tool from Nointel, France, is dated to the early Bronze Age. The Carnon pick was accompanied by a human skull, horns, and a wooden shovel; these objects lay far below present sea-level and also below a layer of oyster shells *in situ*. In stream-works at Pentreven relics of human occupation were found 40 feet below the surface and also below a stratum yielding remains of an extinct whale, *Eschrichtius robustus*. Carey in his survey says that picks of holm (holly), box, or hartshorn were found daily among the refuse of old works in his time, 300 years ago. In nearly all the old tin streams, blocks of stone with cup-like hollows, due to their use in pounding the larger lumps of ore to powder, have been found at varying depths. A good many bronze axes have also been found. That no actual tin mines of Roman or earlier date are known need not surprise us, since the early works were all alluvial.

Another important find is the tin ingot from Falmouth harbour. It is $2\frac{1}{2}$ feet long and now weighs $159\frac{1}{2}$ lb., but a small part has been removed for analysis. Its shape is admirably adapted for transport either at the bottom of a boat or by pack-horse: for the latter the weight, 160 lb., is correct, one ingot being strapped on each side. In one corner it is stamped with a miniature representation of itself, presumably a trade-mark. There is nothing about this ingot to give an exact date, but the type is undoubtedly early. In the Manchester Museum there is a set of foundation deposits from a temple of Tausert, a queen of the 19th Egyptian dynasty at Thebes: it consists of miniature tools, etc., in sheet copper and includes an ingot very much like that from Falmouth, with which it has been compared by Flinders Petrie; the date is about 1200 B.C. A somewhat similar ingot, probably of copper, is shown in a fresco in the tomb of Rekhmara as part of a tribute from Cyprus; this dates from about 1447 B.C. An ingot of this form has been found at Enkomi, Cyprus, with Mycenean relics; it weighs 81 lb. and is stamped with a character in the ancient Cypriot script; it is now in the British Museum. Similar ingots come from Sardinia and Crete.

All the available evidence for tin working in Cornwall from the earliest times up to and including Roman has recently been collected by Hencken in the County Archaeology and recorded in map form. No doubt much of the tin obtained was used at home. Early Bronze Age weapons in Britain may have been imported, but by the Middle Bronze Age they are probably indigenous. A small whorl or bead of pure tin has been discovered at Glastonbury in the Iron Age lake-dwellings.

To learn something of the export trade in tin from Cornwall we must turn to literature. The earliest records are extracts from the lost writings of Pythias by the Greek historians Strabo and Diodorus Siculus. About 325 B.C. Pythias sailed from Marseilles to Brittany, Cornwall, along the south coast of Britain, to the Baltic and back. Tin was then, apparently, shipped to the

mouth of the Loire and taken thence either over land to Marseilles or more probably, as Hencken suggests, on by sea to the Garonne and through the Carcassonne Gate to Narbonne. There is good evidence that this trade route was in existence by 450 B.C. and continued till the port of Corbilo at the mouth of the Loire was destroyed by Julius Caesar in 56 B.C. After that we hear no more of British tin.

If we turn to the details of the various early writings on the subject we find ourselves involved in two much discussed questions. We learn that the tin came from the Cassiterides or Tin Islands, a group of ten or fourteen off the coast of, or near to, Britain. After being cast into ingots it was conveyed to the island of Ictis which, at low tide, was accessible by a causeway from the mainland. There are no plausible candidates for identification with the Cassiterides; for Ictis there are half a dozen rival claimants. Thanet, at one time a favourite, may, I think, be ruled out. There is much evidence against a close connection between south-east and south-west Britain in early civilization. Clement Reid favoured the Isle of Wight, known to the Romans by the somewhat similar name Vectis. He considered that in the Bronze Age there might have been a connection with the mainland by a hard ridge of Bembridge limestone, covered then at high tide, but now completely eroded by the sea. Though prejudiced in his favour I am inclined to accept St. Michael's Mount, which still answers to that part of the description which I have mentioned. A number of arguments converge in its support. It contains veins of tinstone and there are abundant remains of ancient scoriae, showing that it was a smelting centre. Again there is a close geographical resemblance between it and the ports of Tyre and Sidon. The Phoenicians, with whom the origins of the tin trade and the first knowledge of Britain have always been associated by tradition, seem to have had a great liking for peninsula sites resembling their home ports; practically all their colonies, notably Cadiz, are of this type. I do not think there is any solution to the question of the Cassiterides; Rickard's conclusion is that "not enough note has been taken of Strabo's remark that the Phoenicians tried to mislead their contemporaries as to the whereabouts of the tin mines," and Haverfield's is practically the same. The Cassiterides may well have been a geographical Mrs. Harris.

The tradition that the Cornish tin trade was begun by the Phoenicians goes back a long way and has much in its favour. They were certainly the earliest long-distance navigators of the Mediterranean and were the first to sail through the Straits of Gibraltar; they founded Cadiz about 1100 B.C. Ezekiel, writing about 600 B.C., says that the markets of Tyre supplied silver, iron, tin, and lead from Tarshish, which was certainly Cadiz and its neighbourhood. They may well have known of the existence of Britain by 1000 B.C., though the earliest statement we have is Pliny's: that Himilco, a Phoenician, made a voyage to Britain about 500 B.C. It was the tradition of this early Phoenician trade that inspired the expedition of Pythias from the Greek colony of Marseilles about 330 B.C., and two hundred years later the visit of Posidonius, who found the export of tin to the continent flourishing and the miners civilized, hospitable, and expert.

Moreover, precise archaeology is constantly tending to confirm the tradi-

tion against the scepticism of a few years back. At Gaza in Palestine Flinders Petrie has found ornaments of gold, which he says are undoubtedly of Irish origin and manufacture, dating back to about 1200 B.C., and Calais beads from Brittany are known almost as far back as those from numerous localities round the eastern Mediterranean. An Irish halberd of the earliest Bronze Age has been found in the bed of the Loire, an indication of the probable route for this trade; and in the opposite direction, though much later, various Mediterranean coins and four Greek lekythoi of the fifth century B.C. have been found in Cornwall.

There is an undoubted connection between Cornwall and Brittany, and thence through southern France to Portugal and Spain, from Tardenoisian times before the dawn of the Bronze Age. The megalithic culture spread from Spain and Portugal to Brittany and its islands, to Cornwall and the Scillies, and thence by west and north Britain to Orkney and Scandinavia. Thus we may suggest that Brittany, also a tin-producing area, was throughout the Bronze Age a stage in the route by which Irish gold and Cornish tin reached the Mediterranean. The early merchants avoided long sea voyages whenever they could and even cut across land to escape rounding stormy headlands: the Bronze Age route from Egypt to Greece did not round the eastern end of Crete, but crossed the island by land. Similarly I should expect the Cornish tin to be brought along our south coast to near the Isle of Wight, thence by the short passage past the Channel Islands to northern Brittany and then by land to Vannes and Corbilo, avoiding the dangers of Ushant. In the north of Brittany there are several harbours of the Phoenician type; Mont St. Michel closely resembles St. Michael's Mount, with which it has many connections. Even in medieval times the two were sometimes confused, and a legend, belonging to the French site but wrongly transferred to the British, has been used as an argument against the identification of the latter with Ictis. The present route from England to Brittany is Southampton to St. Malo. Close to the latter is St. Servan, a port of Phoenician type whose known history goes back to early Roman times. I suggest that this route was open at any rate by 1000 B.C., but much more evidence is desirable. When the inquisitive Greeks tried to learn whence the tin came the accounts they got were garbled—both innocently by the ignorant and intentionally by those who had a valuable secret to keep. We are even told by Strabo, after his account of the Cassiterides, that on one occasion a Phoenician ship engaged in the tin trade was followed by a Roman vessel. Rather than betray the secret the Phoenician captain deliberately led it to destruction. He escaped with his life and the merchants showed their appreciation by giving him the value of his lost ship and its cargo. We need not be surprised that the surviving statements about Ictis and the Cassiterides are irreconcilable with the facts.

We have seen that the export of tin from Cornwall practically ceased about 55 B.C. After the conquest the Romans seem almost to have neglected it for many years. At Tregear near Bodmin a few mining tools have been found accompanied by coins and pottery dating from the middle of the first to the middle of the second century, but the settlement was small and probably native. Other relics occur in Penwith, but the trade was short-lived. A

possible indication of this early Roman working was found at Lyons: a hoard of 700 tin denarii of Septimius Severus (193–211 A.D.). His visit to Britain may have suggested the use of tin to eke out the scanty silver coinage, but the experiment was not unnaturally dropped; one of these coins is also recorded from Córdoba, Spain. About the year 250 the working was revived under imperial control. Objects of tin and pewter became common, but actual remains of mining are scarce and seldom datable; oaken shovels found in stream-works may be of almost any date from Bronze Age to the seventeenth century. A tin-smelting furnace at Trereife has been claimed as Roman, but it and a block of tin from it bearing a merchant's mark are more probably medieval.

Conclusion

In 'The technical arts and sciences of the Ancients' (London, 1930), A. Neuburger, remarks that "the art of mining appears to have made almost no technical progress during the whole of antiquity, that is, from the date of the earliest traces recorded to the fall of the Roman Empire." We have seen that the earliest mines blindly followed the winding courses of veins; whereas later works within the period employed vertical shafts met at depth by horizontal adits, a process involving considerable skill in surveying; that ventilation was provided for by sinking shafts in pairs and running parallel roads, stoppings being used to control the air current in cross-cuts; that legislation was introduced to ensure efficient support of roofs; serious problems in dewatering were tackled, and even pit-head baths established. Surely these facts prove a real and interesting development of the art of mining, and show that it is worth while to collect more evidence. It should be possible to test further the suggested "Tin Route" from Cornwall to the Mediterranean. In Britain, again, we know that the Romans made use of coal in many parts of the country, and there are traces of its use in earlier times. In southern France two instances are known where Roman works cut through a seam of coal, but no evidence has been found to show that it was used. Coal is mentioned by Theophrastus: has coal-working any history to cover the gap? It has recently been proved beyond question that in this country the Romans sometimes deliberately made cast iron. For many years it was generally assumed that cast iron could not be made; any objects found in datable deposits were regarded as intrusions and fragments of the material as accidental, although there are several allusions to it in classical literature, notably in Pausanias, Book III—"Theodorus the Samian (*circ.* 600 B.C.) who invented how to pour (διαχέαι) iron and to fabricate statues from it." Cast-iron objects should be searched for both by excavation and in collections and records. The writer has collected evidence to suggest that Roman mining men in Britain used the finely crushed quartz incidental to the work as an abrasive with which to engrave gems in their spare time, but a request for information bearing on this point from other countries (*Antiquity*, 8 (1934) 462–3) has not produced anything. Many other gaps in our knowledge remain to be filled. It is hardly likely that such well-developed mines as the Romans possessed in Spain or the Greeks at Laurium remain to be discovered; these have been described above in some detail, partly for their own interest, partly

so as to include mention of all the classes of evidence for mining that travellers are likely to find. The presence of metallic ores or other valuable minerals or gems such as turquoise, emerald, peridot, etc., can easily be recognized, usually by their lustre or colour. Where these occur, signs of excavation will be noticed by any archaeologist; if extensive, a mining man should if possible see them. In many cases the rock must be reduced to powder and the heavy material separated by washing with water. Ancient mills and mortars or hollowed stones may be found; the washing tables or the means for bringing and storing the necessary water may serve to indicate mining activity. Metallic ores will usually have been smelted to produce metal close to the spot where they were obtained. Remains of the furnaces may be found; they will usually resemble those still in use among primitive peoples, as in Africa, and the question of dating becomes important. More common are heaps of slag or furnace-waste, amongst which datable objects may often be found. Except in volcanic regions, where somewhat similar natural products may occur, the slag would be obviously artificial; it will however be more cindery and less glassy in appearance than the blast-furnace slag familiar in this country as road-metal, since the temperature reached was not sufficient to reduce the whole charge to the liquid state. Ancient iron furnaces or bloomeries produced a spongy mass of solid iron which was purified by hammering to form a "bloom"; this could be wrought but not, as a rule, cast. In all ancient works the cindery slag is likely still to contain a high proportion of metal. The presence of this material cannot always be relied on to indicate the exact site of metal working, since the Romans, at any rate in Britain, used the slag as we do for road-metal. From such signs any mining or metal-working site should be recognized. It is hoped that this paper may stimulate explorers and archaeologists to pursue the investigation as far as possible when a site is found.

DISCUSSION

Before the paper the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: Mr. Bromehead has made a particular study of ancient mining, and will this afternoon give us some of its history, which for geographers has a twofold interest. The traveller-geographer finds in many parts of the world evidence of old workings, or what he thinks may be old workings; and if he knows something of ancient mining methods he knows much more what special points to look for and how to interpret them, at least provisionally. The historical geographer is greatly concerned with ancient trade routes, in which study some knowledge of ancient mining is essential. Whether we are explorers or historians, we shall expect to learn much from Mr. Bromehead. Perhaps he will tell us, in particular, something of the British tin mines and our trade with the Phoenicians.

Mr. Bromehead then read the paper printed above, and a discussion followed.

Professor C. H. DESCH: Mr. Bromehead's delightful account of ancient mining has called attention to a subject which has not received as much attention as it deserves. Archaeologists are now taking very great interest in metal objects, which are being used, along with pottery, for dating; but there is not yet enough knowledge of the sources of the metals of which the objects are made.

Under the auspices of a Committee of the British Association an attempt has been made to trace the origin of the objects used by certain people, particularly the Sumerians, by making a chemical analysis and noting the impurities present in the metals. Take bronze, for example; whatever the proportions of copper and tin, one may find small quantities of such impurities as nickel, arsenic, antimony, and so on. To discover mining sites in which the ores contain those particular impurities offers a means of tracing the origin of the objects. For instance, during the excavations made by Sir Leonard Woolley at Ur, at a particular period the copper objects began to show appreciable quantities of nickel and arsenic. Copper ores containing those impurities are abundant in Anatolia, which suggests that at that time either the people bringing those objects or the metal for making them came from Anatolia. It so happens that just after that report was prepared Sir Leonard Woolley said that from entirely separate evidence he had concluded that at that period the region of Ur was occupied by people from Anatolia. This method can be used to a great extent, but the Committee has had difficulty in getting information as to the ores. Those who travel notice the sites of ancient towns but not sites of ancient mines. Again, as methods remain unchanged for a long time, it is difficult to date the mines. Some friends in the Anglo-Iranian Oil Company, while going through remote parts of Persia, made a note of what were called ancient mines, but then the people living in a remote district describe as ancient something that may be seventeenth or eighteenth century or may be 3000 B.C. It is about the latter period that information is wanted.

The last part of the paper dealing with the origin of tin is exceedingly important. No light has been thrown yet on the mystery of how bronze originated. How was it found out that by mixing an inconspicuous black ore with the conspicuous malachite it was possible to get something so much better than copper? It was not that the workers took tin and added it to the copper. Tin was not made, so far as we know, until much later. How the discovery was made is one of the questions we want answered.

Dr. HUGH SCOTT: I would like to ask the lecturer if the methods still employed by remote and primitive tribes, in Africa particularly, throw any light on this subject. I have specially in mind those strange tribes known as the Falasha, professing the Jewish faith and living in the northern part of Abyssinia. They have been the traditional iron workers of Ethiopia through time immemorial. I know parts of Abyssinia, but I have never succeeded in getting far enough north to see the methods employed by these people, nor have I read all of the literature specially devoted to them. The Rev. Henry A. Stern ('Wanderings among the Falashas in Abyssinia,' London, 1862, p. 320) wrote that "the process of smelting, though effected with no other machinery than two rude hand-bellows and a hole in the ground, produces, nevertheless, a metal which establishes the superiority of the ore." It may be asked whether more knowledge of the methods used by the Falasha in mining as well as smelting the ore, and those used by other tribes elsewhere in Africa, would fit in with the rest of the subject.

Mr. BROMEHEAD: There is certainly not the slightest doubt that the study of modern methods in primitive countries throws a good deal of light on the ancient methods. Some of the recent illustrations in the *Journal* of modern iron smelting works in Central Africa can be matched almost exactly. Fortunately, we can date by deposits one or two ancient mines where exactly the same method as that now in use has been employed.

As for the origin of bronze, Mr. Clement Reid, my old master, suggested a possible way in which it was discovered (*Man*, 18 (1918) 9–11).

Dr. K. P. OAKLEY: With regard to the dating of the earliest known British

iron mine, there was one of Roman date discovered by Dr. Mortimer Wheeler near the site of the Romano-British temple at Lydney in the Forest of Dean. Close to the settlement around that temple there are a series of depressions in the ground; one of these was excavated in 1929 and proved to be a filled-up mine shaft. Haematitic marl, workable as iron-ore, occurs here in association with the carboniferous limestone. The workings cut through a pre-Roman bank and were therefore post-Early Iron Age. They had been disused before the end of Roman times, for the entrance to the mine was sealed by an occupation-layer containing potsherds and coins which dated its disuse as earlier than A.D. 300.

Mr. W. S. BARCLAY: I can give an instance on the point made by the lecturer that when slave or native labour is cheap primitive methods can persist until a comparatively late date.

I was in Bolivia, about 1910, in the city of La Paz, which lies at 12,000 feet in a valley some 1500 feet below the general level of the high inter-Andean plateau. The eroded *barrancas* or earth cliffs, which form the sides of the La Paz valley, contain alluvial gold, with workings dating from early Spanish times. An American had started about a mile from the town to wash down the cliffs near these old workings, and he pointed out holes in the cliffs at a height of perhaps 60 or 70 feet. He said that in early days the Spaniards used slaves, where certain profitable seams appeared in these cliffs, to fetch out the gold ore. These unfortunate creatures were driven into the face of the cliff carrying a sack. They burrowed in like rabbits, and then dragged out the ore in the sacks backwards, on all-fours, for there was no room to stand. Some of the adits or burrows in the face of the cliff went in for 200 or 300 feet, or even more. One wonders how the workers could possibly breathe. Undoubtedly many died as a result of the work, but labour was so cheap that it did not matter. The American was sluicing down the *barrancas* by water "monitors" fed from the stream higher up. To catch the gold grains he used exactly the method we have heard described. He had no money or means of bringing proper machinery to the spot, but he had arranged boulder "riffles" in such a way that, as the water came down, it carried away the gold and, swirling round the stones, deposited it there till a clean-up was made.

The PRESIDENT: I will now ask you to thank Mr. Bromehead for his most interesting lecture.

Note on plates

2. From the *Geographical Review* 24 (1934) 546.
3. From *Archaeologia* 52 (1910) plate XVII.
4. From Agricola, 'De re metallica.'
5. From Rickard, T., 'Man and metals,' p. 444. (New York and London, 1932.)

ANNUAL GENERAL MEETING

24 June 1940

The President, Field-Marshal Sir Philip Chetwode, in the Chair.

The HON. SECRETARY (Mr. W. L. Sclater) read the Minutes of the Annual Meeting held on 26 June 1939, which were confirmed and signed by the President.

The PRESIDENT then said: It was the pleasure of His Majesty the King, our Patron, that our Council should make as usual this year their recommendations for the Award of His Royal Medals, which recommendations He graciously approved, but signified through His Keeper of the Privy Purse that the Gold Medals themselves could not be struck until the war is over. By this happy decision our Royal Medallists this year enjoy at once the high distinction of His Majesty's award and the expectation of receiving it in kind at we believe no very distant date.

The Founder's Medal is awarded for the first time in our history to a man and his wife jointly, for the work which has been done for geography by Mr. and Mrs. Harold Ingrams is indivisible. Less than ten years ago an air reconnaissance of the Wadi Hadhramaut under the leadership of Squadron Leader the Hon. R. A. Cochrane revealed to us its remarkable cities, increased and adorned by the riches which the Hadhrami Arabs have brought home from their enterprise in the East Indies, but almost unknown except by report. Mr. Harold Ingrams, after distinguished service and severe wounds in the war of 1914–18, had learned in Zanzibar that knowledge and sympathetic understanding of the Arab which has served him so well in the Aden Protectorate. After successful journeys of exploration with his wife in that remarkable country to which the R.A.F. had opened the way, Mr. Ingrams was made the first Political Resident at Mukalla. From this time they were not always able to travel together. If he was away on a distant reconnaissance by aeroplane or by camel, the business of the Residency was in the hands of Mrs. Ingrams. If on the other hand he was kept at headquarters, it was Mrs. Ingrams who went exploring: so that when the project of a truce to internal warfare was at last possible he was able to make the peace in places that Mrs. Ingrams had already visited and studied in spite of the warfare. Papers contributed to our *Journal*, and in particular that most able account of the country which he gave us in the summer of 1938, are themselves ample grounds for the Council's recommendation to His Majesty, but cover only a small part of what our Medallists have done jointly to extend our knowledge of one of the strangest parts of the world. Mr. and Mrs. Ingrams received news of the Award at Seiyun, in the Wadi Hadhramaut, only three weeks ago. I will ask the Honorary Secretaries to convey to them your congratulations and good wishes.

The Patron's Medal is awarded to Lieutenant Alexander R. Glen, R.N.V.R., for his expeditions in Spitsbergen and in North-East Land. Having been a member of the Cambridge Spitsbergen Expedition of 1932, he organized in the following year an Oxford expedition of eighteen men to the northern part of New Friesland, and unexpectedly succeeding to the leadership, proved then his great capacity. So in 1935 he planned a much more ambitious expedition for twelve months in North-East Land, enlisted several trained physicists in

his party of ten, maintained two stations on the Ice Cap throughout the winter, and established a whole new technique of wintering in the worst conditions and keeping perfect health. We have already published much from him in the *Journal*, and have still more to publish on the results of this very important expedition. Lieutenant Glen is far away on naval service in which we are confident he will gain further distinction.

On the death of Queen Victoria the Council resolved to institute the Victoria Medal to be awarded from time to time for conspicuous merit in scientific geography, and it is awarded this year to Mr. O. G. S. Crawford, Archaeology Officer of the Ordnance Survey, whose official duty it is to put the antiquities shown on the maps of Great Britain in accurate shape; with the result, I am assured, that our maps are in that particular without rival elsewhere. To achieve this he has been untiring in promoting archaeological mapping from the air. He has also with the approval of his successive chiefs been the prime mover in that series of Period Maps of the Ordnance Survey which have proved so valuable in education. Further, as Secretary until lately of the Executive Committee, he has played a principal part in producing the International Map of the Roman Empire. Outside his official duties he has founded and edited with distinction that most valuable journal *Antiquity*, and has published several books on air photography and archaeology. Circumstances of the time have required that the Victoria Medal be struck this year in bronze instead of in gold. I ask Mr. Crawford to receive it in token of our very sincere appreciation of his excellent contributions to historical geography.

Mr. O. G. S. CRAWFORD: I appreciate very highly indeed the award of the Victoria Medal by the Society. It was the Royal Geographical Society which encouraged and eventually published my first attempt at archaeological mapping in 1912. The sketch-maps there printed were the progenitors of the later and much more elaborate ones; and these are all written in the script conceived and developed by this Society. To be honoured for cartographical work by the Royal Geographical Society is a very great distinction, and I am most grateful to you for it.

The PRESIDENT: The Murchison Grant is awarded to Mr. Peter Mott for his surveys in West Greenland, which began in 1935 when a party of four landed in the Søndre Strømfjord to investigate the Sarfartok river. In the following year he led a larger party which traced the river to its source in Lake Tasersiak, and found that the Rasmussen Ice Arm is distinct from the main Greenland ice-cap. In 1938 a third Oxford party was led by him to the same neighbourhood to continue and complete this work by glaciological observations to compare with those of Wegener on the north ice-cap, Ahlmann in Spitsbergen, and Glen in North-East Land. Much of the work on these two expeditions has been published in the *Journal*, and the Award is given for this. He has since devoted himself to photogrammetric survey, and was one of Shipton's party to the Karakoram of whose excellent work we heard recently from Mr. Scott Russell. Mr. Mott remained with his leader in India after the outbreak of war, and is now on military service. I will ask his mother, Mrs. Mott, and sister, Miss Mott, to receive on his behalf the Certificate of the Award and the accompanying cheque.

The Back Grant is awarded to Mr. Gerald Seligman for his glacier studies conducted last year on the Jungfraujoch. With a small team of specialists working in a laboratory excavated in the glacier curtain, and so kept automatically at freezing-point, he has obtained important evidence of the method by which the snow of the *névé* becomes transformed into the ice of the glacier, and on the process of movement. We have in our possession, and are studying how in these difficult times to publish, a Memoir describing and illustrating this work. Mr. Seligman is on duty with the Royal Air Force Meteorological Service, and unable to be present this afternoon.

The Cuthbert Peak Grant is awarded to Mr. John Hanbury-Tracy for his work in south-eastern Tibet and his more recent journey in South America. In Tibet he took an active and partly independent share in the remarkable expedition that Mr. Kaulback described to us, and of which Mr. Hanbury-Tracy has published his own account in a book. His interests are more particularly in the people. His studies of the Indians of the northern Andes were described by Mrs. Hanbury-Tracy, who went with him, at one of our meetings. Its publication has been delayed by the prior claims of military service. Mr. Hanbury-Tracy is on active service with the Brigade of Guards, but Mrs. Hanbury-Tracy is present, and I have much pleasure in asking her to receive for him the Award in which she has a right to share.

The Gill Memorial is awarded to Mr. Alexander King for his work in Jan Mayen in 1938, when he organized and led a party of specialists from the Imperial College of Science, whose doings he described in an excellent paper last summer. They surveyed the crater of Beerenberg and its glaciers, and carried out a very complete scientific programme: a good example of the modern exploration which establishes specialists in field laboratories. Mr. King is happily able to be present this afternoon, and in handing him the Award of the Gill Memorial I congratulate him upon the success of his expedition from the Imperial College of Science.

Mr. ALEXANDER KING: I thank the Council very deeply for this award, which is specially encouraging to us since the expedition to Jan Mayen was the first to go out from the University of London. We hope it will prove to be the first of many.

The PRESIDENT then delivered the Presidential Address, which is printed on pp. 81–84.

Visitors having withdrawn, the PRESIDENT appointed Lieutenant N. E. Odell and Mr. O. G. S. Crawford to act as scrutineers of the ballot for the Officers and Council for the ensuing year.

The PRESIDENT, in submitting the Annual Report of the Council, said: The Bye-laws provide that no resolution be passed at the Annual General Meeting. If any Fellow desires to bring forward a motion on any point in the Report of the Council, this motion shall be handed in, read, and if supported by not less than forty Fellows present, will be referred to a Special General Meeting. This procedure does not however debar any Fellow from making observations or asking for information upon the Report. It provides only that no formal resolution shall be discussed at this time.

Admiral Sir WILLIAM GOODENOUGH: I should like to say that the Report is

most encouraging. Speaking as a past-President, I feel that the affairs of the Society are in a very happy state. They are a source of hope for the future.

The PRESIDENT: I agree with the Admiral that, considering the untoward circumstances of the present time, it is remarkable that the Society has been able to show such a satisfactory record. Fortunately, many Fellows who resigned from membership later rejoined and many have gone to a great deal of trouble to obtain new Fellows. At every meeting new proposals have come forward.

I think I should here refer to the retirement from the Council of Sir Charles Close. Sir Charles was President from 1927 to 1930, and I believe he was for something like thirty years a member of the Council. The Society is very greatly indebted to him for all the work he has done on its behalf.

The scrutineers then informed the President that the candidates proposed by the Council had been elected (see list, p. x). There being no further comments, the President, on the proposal of Dr. L. J. Spencer, put the Annual Report to the Meeting and it was adopted.

GEOLOGY OF CHINA

THE GEOLOGY OF CHINA. By Dr. J. S. Lee. *London: Thomas Murby and Co.*, 1939. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xv + 528 *pages; illustrations, sections, and maps.* 30*s*

A GENERAL survey of the geology of China, comparable to Wadia's of India or Du Toit's of South Africa, has been long overdue. Von Richthofen's classic work dates from sixty years ago. The contributions of Willis and Blackwelder were the result of a single expedition working under reconnaissance conditions at the turn of the century. Only with the establishment of the Chinese Geological Survey in 1918 was a plan of systematic field work inaugurated. The progress of the last two decades has no parallel in any other country. During that period the Survey has issued thirty bulletins, twenty memoirs, and some two dozen palaeontological monographs, while the Geological Society has published twenty bulletins (several of over 500 pages). This is in addition to the long series of provincial reports, soil-survey and seismological bulletins, and local and regional geological maps, including those of the international series. Finally there is the vast hoard of stratigraphical detail amassed in Grabau's compendia: 'Stratigraphy of China' and 'The pulsation theory.' To extract from this wealth of material the elements of a simplified outline is no easy assignment. Professor Lee is one of the few men competent to handle the task, and was accordingly invited by the Universities' China Committee in London to give a series of lectures in British institutions of higher learning in 1934–35. The lectures were later expanded into book form.

The pattern of the volume is somewhat novel. It begins with a thirty-page description of the various physiographic and soil provinces into which the region naturally falls, followed by a useful résumé of early Chinese history. The next forty pages deal with the pre-Cambrian foundations and their structural subdivisions, including the famous Algonkian tillite in the Yangtze Gorges. The Palaeozoic marine transgressions and the related orogenic movements are well summarized in seventy pages, the stratigraphic details of generalized type sections being wisely relegated to an appendix of one hundred pages at the end of the volume to avoid obscuring the main drift of the argument. In a second edition the precise authority for each section should be cited.

China has been continental since the Triassic period; except for brief marine invasions in the Carboniferous, the north-eastern half has been emergent since middle Palaeozoic days. Special interest therefore attaches to the varied story of subaerial erosion and deposit, especially during late Tertiary and early Quaternary times. Among the problems touched upon are those of the Hipparion fauna, the loess deposits, and Sinanthropus (Peking Man). Many of the matters discussed are still open questions, and Lee shows wisdom in presenting both sides of the argument.

The middle third of the book attempts an analysis of the structural history and passes into a more theoretical discussion of the processes of orogenic movement which is extended to cover the mountain systems of the entire globe. The treatment is developed upon the basis of experiments first described by Dr. Lee in the *Geological Magazine* in 1929, and the conclusions will be regarded by some as open to challenge. It may be questioned for instance how far one dare infer, from experimental fold patterns several centimetres in length, that similar superficial outlines imply identical stress developments alike in ridges 2 kilometres in length and in cordilleran ranges. There seems also to be a possible serious source of confusion if parallel cross-faults normal to thrust-folded structures,

which on the map (*e.g.* Fig. 71) have all the appearance of simple tensional faults, are not distinguished from oblique *en échelon* shears.

In the discussion of Pleistocene climatic oscillations Dr. Lee is on surer ground. In view of his strong advocacy of a glacial explanation for certain extremely puzzling physiographic features noted in various North China localities, he is to be congratulated on the restraint and fairness with which he presents both sides of the argument; as, for instance, in the case of solifluction versus glacial transportation.

The volume is very thoroughly indexed and is adequately illustrated except in one respect. Either in the interests of economy or because of uncertainties of correlation, an attempt was made to compress into four text-page black-and-white maps the distribution of the formations of every geological period for the entire Republic of China. The use of various types of stippling and ruling to indicate so many formations on a small-scale map largely defeats its own purpose. The author, editor, and publisher however deserve congratulations. The manuscript was prepared under circumstances that might have daunted other men. The Japanese invasion of Dr. Lee's homeland had already begun, and before the writing was well under way he learned of the tragic death of his close friend and colleague, Dr. V. K. Ting, and was recalled to China to fill his place as head of the Academia Sinica. The manuscript was therefore put through the press by Dr. Dighton Thomas after the author's departure, and to him a special tribute is due. Any one who has wrestled with the variant spellings of Chinese place-names must admit that the compositor and proof reader have done a good piece of work. G. B. B.

REVIEWS

EUROPE

POOLE HARBOUR: a hydrographic survey, 1938–39. By F. H. W. GREEN. *London: Geographical Publications*, 1940. 11×9 *inches; 48 pages; maps and diagrams.* 2*s* 6*d*

In this publication Mr. Green has summarized some useful observations on tidal regime, salinities, and the nature of the bottom deposits of Poole Harbour. This inlet, as the author points out, is rather an anomalous feature of our coastline. It is nearly blocked by two sand spits running from Bournemouth and the north-eastern end of the Isle of Purbeck. It is therefore largely cut off from the prevalent and dominant winds of the English Channel. It is also interesting in that, as in Southampton Water, there are double tides, but the range in Poole Harbour is comparatively small—not more than 6 feet even at springs.

It is no criticism of Mr. Green's work to say that it is confined almost entirely to facts. True, it makes for heavy reading, but it is essential to have a full knowledge of the run of the tidal waters before entering into the perhaps more interesting, but nevertheless more speculative, question of the probable evolution of the main features of the area. With the help of a number of students of the Geographical Department at Southampton University College, Mr. Green has carried out some detailed and careful observations with the help of weighted floats. These floats were attached to light cords and measurements of direction and velocity were made from moored buoys. Other floats were free, and these

were measured by sextant observations: at night this was made possible by affixing an electric light to the floats.

The amount of suspended matter in relation to salinity was also investigated, and is shown in an interesting series of diagrams. We cannot enter into detail here, but will call attention to two points only: the vertical distribution of sediment and salinity appears to show a regular sequence, according to the state of the tide, and the lowest salinities and the maximum sediment content at all depths occurred just at or just after the slack water following low water; conversely, the highest salinities and minimum sediment occur during the slack water period following the main flood. Measurements were made at several parts of the harbour so that a clear picture of the whole was obtained. Most of the suspended material consists of very fine particles of quartz, and occasionally a small amount of iron oxide. Microscopic examination shows that the material closely resembles the sediment on the mud-banks in the harbour, but some of it may be of river origin. The bottom deposits were almost entirely formed of quartz sand, and, allowing for variations in grain size, "there was no general distinction to be found in either form or composition between samples from inside the harbour and from outside." All this material was, in fact, similar to that which occurs in the surrounding cliffs. It was also found that where much water sweeps through a well-marked deep channel it was impossible to obtain bottom samples, as the grabs found only a hard bottom.

Amongst the more important of Mr. Green's conclusions is the view that the main channel tends to migrate eastwards, especially where its curvature is greatest. Whilst it maintains its depth, it narrows because the western edge (*i.e.* the east part of Middle Ground) migrates more rapidly than the eastern bank. Further, there is no conclusive evidence that more sand enters the harbour than passes out of it. As the ebb streams are generally stronger the balance would seem to favour an outward migration of material apart from the effect of strong inshore storms or winds.

Whilst Mr. Green refers briefly to the growth and decay of *Spartina* (rice grass) in the harbour, one cannot avoid feeling that on this matter the thesis is not so full as it might be. He himself suggests that further work on ecological problems is desirable and the reviewer hopes that the time will come when the more particularly ecological and physiographical problems can be attacked. The whole is an interesting and useful piece of work, which can and should be followed up. One or two misprints occur in the present text—*e.g.* (p. 25) the "ebb-a'-flood (or ground ebb)," and (p. 22) ". . . in the grand ebb (ebb-a'-flood)."

J. A. S.

A GEOGRAPHY OF WALES. By A. Norman Harris; with an introductory chapter by H. Hughes Roberts. (Harrap's New Geographical Series. Third series.) *London: George G. Harrap and Co.*, 1939. 7½×5 *inches;* 160 *pages; illustrations and maps.* 2*s* 3*d*

This readable school text-book has many pleasing features: an attractive, concise style, clear printing, many excellent photographs, and admirable sketch-maps and diagrams. The background throughout is structural and topographical; thirty-three pages are devoted to geological factors and their effects on relief, drainage, landforms, and scenery. This section is particularly well done, but over-simplification of structure and lithology leads at times to dangerous generalizations, *e.g.* "Between the Usk and the Wye are the Black Mountains, of higher elevation because they are built of sandstone rock" (p. 50). The other aspects of physical geography receive, in comparison, scant treatment; climate has six pages and natural vegetation one page. Economic and industrial

geography comprises more than one-half of the book, with valuable statistical data in Appendix II, whilst social and human affairs are discussed in some twenty-one pages. It is unfortunate that several errors have been allowed to remain: p. 24, Permain for Permian; p. 45, west of the Conway should be east of the Conway; p. 54, the surface waters around the western shores of Britain are said to be derived from the Gulf Stream; p. 63, cattle in south-west Wales are not fed outdoors on pasture for most of the year; p. 65, Swansea's reservoir is not in the upper Tawe valley; p. 72, the relation between structure and relief is not brought out on the geological section; p. 73, the anthracite area is inaccurately delimited on the diagram; p. 87, Roath Docks are at Cardiff, not Swansea; p. 93, Brymbo is 4 miles north-west, not north-east, of Wrexham; and on p. 123 the distribution of population shown on the map does not include Holyhead and Holyhead Island. D. T. W.

LA MAURIENNE ET LA TARENTAISE: étude de géographie physique. By HENRI ONDE. *Grenoble: B. Arthaud*, 1938. 10×6½ *inches; 624 pages; illustrations and sketch-maps.* (Supplement: L'homme et la nature intra-alpine, pp. 68.) 23*s*

These two volumes, dealing with part of Savoie, form a valuable contribution to the literature of alpine regions. The area lies between the Mount Cenis and the Little St. Bernard passes, and includes the upper sections of the basins of the Isère and the Arc. The whole work is not intended as a complete geographical survey of the region under discussion but attempts a special study only of the physical basis. There is however much material included incidentally that is of value to the human geographer.

The larger volume of some 600 pages deals with the fundamental aspects of the physical basis: structure, relief, and climate. The second, much smaller, work discusses the vegetation of the region, analysed as the product of the interplay of two controls: the natural factors of the physical basis, and the artificial factor of interferences by man. Details of the composition and changes in the vegetation and agriculture are considered in relation to these.

The region is specially suited to the discussion of many of the problems peculiar to alpine regions, for the drainage of the Arc and Isère have cut across and into a complex sequence of geological structures and rock types, and their valleys make units that contrast in their morphology and in other physical characteristics both one with another and within individual sections of each valley. Moreover, since the region as a whole is set within comparatively low latitudes (*c.* 45° N.), yet reaches to very high altitudes, cultivation rises locally to considerable levels where insolation, slope, and soil are most favourable. Thus wheat ripens up to 1800 metres; rye up to 2040 metres; barley, lucerne, and potatoes are grown at least up to 2090 metres; and sheep find pasturage up to 3000 metres.

The main part of the work included in the larger volume is divided into three sections, each of considerable length. The first gives a detailed analysis of the build and morphology of this part of the alpine arc, its nappe structure, and the influence of crystalline rock masses and nappe and fold structures on denudation and scenery. Section II discusses in much detail the various theories put forward to explain the evolution of the present drainage pattern and the development of the valley land forms through pre-glacial, glacial, and post-glacial times. In this the major emphasis is placed on the power of ice to deepen and over-deepen. Examples are quoted to show how small has been the erosive work of rivers in post-glacial time; and where deeply cut gorges exist, it is claimed that these may well be the work of subglacial water action during late glaciation, and

not the work of post-glacial water action alone. A feature common to many alpine valleys, and which does not always receive attention by geomorphologists, is the occurrence along a single valley profile of alternating valley cross sections, both U-shaped and V-shaped. These are here accounted for as due to varying intensities of ice erosion and not to erosion by water action. In the analysis of bench formation also, benches are explained in this area as the product of differential ice erosion and their origin as the result of polycyclic valley development is refuted. It will be evident from these remarks that in this work there is no place for the theories which attribute to water action, during interglacial and pre-glacial times especially, an important rôle in the evolution of alpine land forms generally. The third section deals with climate, giving detailed surveys of the temperature, precipitation, and influences of relief on the duration of sunshine, etc., and of such allied subjects as hydrology, floods, and avalanches.

Throughout both works there are many illustrations and photographs, and many diagrams. These compensate to some extent for the absence of good maps in the text. An important feature of both volumes is the full bibliography, which, though limited almost exclusively to French and Italian publications, none the less makes the work one of value and importance to all students of alpine geography. A. Gt.

DANUBE STREAM. By Lovett Fielding Edwards. *London: Frederick Muller*, 1940. 6×5½ *inches;* 243 *pages; illustrations and map.* 12*s* 6*d*

THE DANUBE. By Emil Lengyel. *London: Victor Gollancz*, 1940. 8½×5½ *inches;* 382 *pages; illustrations and sketch-maps.* 16*s*

To escape the heat and flies of Belgrade in summer Mr. Edwards set out with a companion aboard the cargo steamer *Bujović*, which was bound for the lower Danube. At Kladovo he transferred to the *Marko* which took him down as far as Rustchuk, whence he returned to Belgrade. Since he is concerned only with this stretch of river, Mr. Edwards is able to describe somewhat fully what he saw of the country and its people and what he knows of its history and prehistory. There is actually more history than first-hand description, and the reader should have no regrets, for no country has a richer and more dramatic history than the old Serbia, and no European river, save perhaps the Rhine, has such an unbroken history, as epitomized in its cities, through neolithic, Roman, and medieval times. Unfortunately Mr. Edwards's history is not always accurate: he assigns to the Hungarian general Hunyadi in 1450 the Serbian defeat at the Battle of Kossovo in 1389 (p. 26) and presents Trajan to us long before he was born (p. 69). The map is inadequate for the intelligent reader and much below the standard of the photographs.

Mr. Lengyel takes as the subject of his book the whole basin of the Danube, both in space and in time. As he moves slowly downstream from the Black Forest his account ranges over the whole field of European history, enlivened continually with legend and anecdote and including the political events of very recent times. The book is discursive and unsystematic, but Mr. Lengyel has a light touch and conveys to his readers boundless information, important and trivial, in lively fashion. It seems a little hard to saddle the Danube with all the conflicts of the political and dynastic history which were enacted within its basin, but no one can dispute, however difficult it is to define, the close interrelation of geography and history in this part of Europe. The maps are meagre in content, but this may matter little in a book of a dramatic character intended for the general reader. W. G. E.

[THE GLACIAL PERIOD IN THE TERRITORY OF U.S.S.R.] By I. P. GERASIMOV and K. K. MARKOV. ("Trudi" of the Geographical Institute, vol. 33.) *Moscow: Academy of Sciences*, 1939. 10×6½ *inches; 462 pages; illustrations, maps, and diagrams. In Russian*

In a comparatively short but quite adequate English summary of this book only the general conclusions are presented. They are important, but in the Russian text the conclusions reached are based on a most careful and methodical marshalling of data and on a critical examination of the evidence, and it is unfortunate that the reader dependent on the English summary must forego what is certainly the most valuable part of the work. The same limitation applies to this review which, while it can record appreciation of the task accomplished by the authors, can do little to enlighten the English reader on the material and the processes of thought underlying their conclusions.

The problem of the glaciation of the vast territory of the U.S.S.R. is very difficult, and at the outset the authors give a warning against hasty generalizations and especially against comparison and correlation of glaciation stages, faunal and floral zones, and other data of widely separated areas. Probably one of the most important features of the glaciation of the territory of the U.S.S.R. is the position of the margin of maximum glaciation. On entering the U.S.S.R. from Poland at lat. 52 N. this margin forms two large tongues along the Dnieper and the Don respectively, and then, before reaching the Volga, strikes north and follows approximately lat. 62 N. until it reaches the Yenisei, where it strikes north-north-east and finally reaches the Arctic coast at long. 115 E. This leaves the whole of southern, middle, and eastern Siberia unglaciated by the major glaciation. On the other hand the region of the permanently frozen ground in Siberia, with the exception of north-western Siberia where it overlaps the glaciated area, is situated outside the margin of maximum glaciation. The nature of glaciation in different parts of the country suggests three contrasted regions: the region of the European glacial shield, where intensive glaciation resulted in the formation of a large shield-like mass of active ice the centre of which was situated in Scandinavia; the region of the north-western Siberian ice-sheets in which only comparatively thin ice-sheets, with local centres situated in Novaya Zemlya, Taimir, the Urals, and Severnaya Zemlya, were present; the sparsely glaciated region of middle and eastern Siberia with only small local highland, piedmont, and intermontane glaciers. Apart from these three major boreal regions the mountains of the southern border of the U.S.S.R., from the Caucasus to the Pacific Ocean, had their own glaciation during the Pleistocene.

The idea of a universal synchronization of glacial epochs is strongly criticized by the authors, who themselves suggest a metachronous development of glaciation. According to them glaciation is determined not so much by the general lowering of the temperature as by the relative amount of winter precipitation which, in its turn, is determined by the prevalent cyclonic and anticyclonic conditions. The prevalent cyclonic conditions of western Europe promoted the formation of the ice-shield, while the prevailing anticyclonic conditions in eastern Siberia (long cold winters with low amount of precipitation and short hot summers) favoured not glaciers but the formation of the frozen ground. Their acceptance of the principle of metachronicity also prevents the authors from giving a precise correlation of the glacial stages of European Russia with those of western Europe. They prefer local names for the Russian glacial stages: the Lichvin, Dnieper–Don, and Valdai stages (in chronological order). The general conclusion is that the intensity of glaciation diminished eastwards, from the region of marine climate to the region of continental climate. There is a good account of the glaciation of the mountains.

Almost half of the book is devoted to the study of the non-glaciated regions, including a detailed account of the history of the sea basins during the Quaternary age. Here also the authors have very adequately handled the enormous collection of miscellaneous and often contradictory data, and have produced a clear and reasonable picture of successive events. Generally speaking the non-glaciated regions of the U.S.S.R. display throughout the Quaternary a considerable stability of climatic and geographical conditions. The principal climatic factor was probably the prevalence of pluvial periods. Even in the long-established desert region of central Asia there are indications of buried soils and remains of former forests, suggesting greater precipitation during the glacial age. The pluvial phases appear on the whole to be synchronous with the European glacial phases. The conditions of accumulation of alluvial deposits and loess are also discussed. In the authors' words "the most remarkable event of the Quaternary age in the middle and southern part of the Russian plain was the accumulation of loess and loess-like deposits." On the formation of loess the authors have much to say, and they boldly attack the all-embracing eolian hypothesis. According to them the evidence suggests that loess is mostly of alluvial, fluvio-glacial, and even eluvial origin. The authors have also a great deal to say about alluvial plains and the evolution of land forms during and after the glacial age. In the last part of the book the palaeogeography and the biological and chemical changes of the Black, Caspian, and Aral seas are discussed. The shifting of the route of cyclones during the glacial age led to the increase of precipitation and consequently to the increase in the volume of rivers in the Ponto–Caspian region. This in its turn affected the regime of the seas with their ever-changing margins and their alternation of fresh and salt water conditions.

The book is full of valuable data, is well written, and well illustrated by maps, diagrams, and photographs. It is a valuable contribution to Quaternary geology, and even the perusal of the short English summary is worth while. Every chapter is accompanied by numerous bibliographical references, but unfortunately there is no index. S. I. T.

ASIA

L'UTILISATION DU SOL EN INDOCHINE FRANÇAISE. By PIERRE GOUROU. (Centre d'études de politique étrangère. Trav. des groupes d'études, Publ. 14.) *Paris: P. Hartmann*, 1940. $8\frac{1}{2}\times6\frac{1}{2}$ *inches;* 466 *pages; sketch-maps and* 5 *maps in pocket. Fr.*55

The author of 'Les paysans du Delta Tonkinois' and other detailed studies has now compiled a general geographical account of French Indo-China. The first part is devoted to physical conditions, the second to the distribution of population, and the third to economic conditions. Recent developments resulting from European influence are purposely excluded. The work is a painstaking summary of published material; there is little to suggest first-hand observation or independent analysis. The poorly executed line blocks convey rather less than the official maps on which they are based, whilst the five folding plates (scale 1/250,000) show in black the cultivated village lands normally in green on the 1/25,000 sheets of the Service Géographique but have the advantage of affording a general view of population distribution. References are mainly to works in French on Indo-China; there are a few references to China, but it is something of a tragedy that linguistic or political boundaries should prevent attention being paid to excellent scientific work in other parts of Indo-China (in Siam and Burma), or even in India and Malaya. For example, the brief account of natural vegetation would have gained greatly had the types mentioned been linked with

those carefully described from Siam by Credner or from India and Burma by Champion and others. L. D. S.

AFRICA

AFRIQUE SEPTENTRIONALE ET OCCIDENTALE. By AUGUSTIN BERNARD. Sahara—Afrique occidentale (Géographie Universelle. Edited by P. VIDAL DE LA BLACHE and L. GALLOIS. Tome XI. Deuxième partie.) *Paris: Armand Colin*, 1939. 11½×8 *inches; pages* 285–530; *illustrations and maps.* 110*fr.*

Of the three volumes which were intended to cover Africa the present one, long awaited, completes the set. The choice of Professor Bernard for the earlier volume, which described the Barbary lands, was felicitous; and the same may be said with regard to the section of the present book which concerns the Sahara. With the exception of E. F. Gautier, there has been no one in our time more competent than Bernard to elucidate the features of "the great desert," although the author would readily admit that his knowledge of the region is most profound in the case of the north-western districts, now administered along with the Barbary dependencies of France.

In addition to the Sahara the Guinea lands of West Africa are included, and the allocation of page space to the two regions is almost exactly equal and rather more than one hundred pages in each case. Herein lies perhaps the main criticism of the volume, for from the standpoint of a geographical treatise West Africa is of much greater significance. Indeed there would have been no serious disproportion if the Guinea region had been allotted at least double the space granted to the Sahara: the disproportion is an almost inevitable consequence of the special interests of the author. It is likewise inevitable, so long as national bias operates in the study of geography, that the several territories of British West Africa will receive less attention in a book published in Paris than those Guinea lands which are under French control. Yet allowing for such nationally inspired emphasis, it is still surprising to discover how little space has been allowed to Nigeria, the Crown Colony which may be described as the eastern centre of gravity of the Guinea region. The space devoted to Northern Nigeria is actually only one page apart from the introductory references to the region which all territories share, and consequently there is no opportunity of even indicating some of the important characteristics and problems of one of the largest, most crowded, and culturally advanced territories of tropical Africa. Amongst other easily apparent deficiencies is the inadequate reference to the Italian colonization of Libya.

On the other hand, the study of the Sahara is not only comprehensive but nicely balanced. It refers to the most recent investigations into the climate of Ahaggar, the central highlands of the Sahara. Since 1933 an observatory has been established at Tamanrasset, which is situated where both winter rainfall (characteristic of the northern parts of the Sahara) and summer rainfall (characteristic of the southern parts) are perceptible. In some years there is no rain at Tamanrasset; in others there have been showers both in summer and in winter.

The high standard of cartography which we have learned to expect from the volumes of 'Géographie Universelle' is well maintained. We have now for the first time in convenient compass a map showing the distribution of population density for the whole of West Africa. Perhaps the author will accept the suggestion that for the very complicated drainage and irrigation systems of the Middle Niger there might be, with advantage, a large-scale sketch-map which

would show, in easily seen detail, both the natural and the artificial waterways in the part of the river basin between Ségou and lake Débo. For the photography the praise can hardly be exaggerated. The best photograph of the Saharan landscape which the reviewer has seen faces p. 310: it shows the contact of the *erg* and *hamada* in the valley of the Zousfana. W. F.

THE ECONOMIC DEVELOPMENT OF MODERN EGYPT. By A. E. CROUCHLEY. *London: Longmans, Green and Co.*, 1938. 7½×5 *inches;* viii + 286 *pages; sketch-map.* 8*s* 6*d*

Mr. Crouchley gives here a concise and readable outline of the remarkable economic transformation of Egypt since the year 1800, together with a brief account of the earlier history. In 1800 Egypt was still a backward, secluded, and feudalized country, and winter crops grown by basin irrigation provided subsistence for its small population of two and a half millions. Alexandria had then 15,000 inhabitants, and Suez only 200. There was no internal market since transport facilities were bad and unsafe. The great achievement of the nineteenth century was the extension of summer crops—indigo, rice, flax, and above all cotton—as a result of perennial irrigation. No less important were the improvements in internal communications and transport. First a road, then a railway, and then the Canal made Egypt once again part of a world highway, not without international complications. Under Mehemet Ali, Egypt became for travellers "as safe as Yorkshire and much safer than many parts of Ireland," whilst the steamship linked Egypt with India and with western Europe from which essential capital and technical services were derived.

Perhaps the most interesting section of Mr. Crouchley's book is his sketch of the work of Mehemet Ali, an Albanian captain who secured Egypt as an hereditary pashalik. His military and political activities are probably better known than his internal administration, here described, which made them possible. His shrewdness, imagination, ambition, and iron will certainly initiated Egypt's material progress. He cut the Mahmoudia canal and rebuilt Alexandria, extended summer crops, encouraged trade, and started the construction of the delta barrage. It was during his reign that the cotton trade began and rapidly grew: the export of cotton in 1824 was more than two hundred times that of 1821, and it amounted to nearly one-third of total exports by 1849. Mr. Crouchley believes that the cultivable area of Egypt can be increased by 50 per cent. by further irrigation and drainage, and that Egypt is in no sense over-populated.

The book contains some useful statistical tables and a short classified bibliography. A few dates and figures have gone wrong. On p. 90 the dates 1823, 1824, and 1825 should read 1822, 1823, and 1824; 1415 should be 1520 on p. 13; and "nineteenth" should read "eighteenth" on p. 94. W. G. E.

MISSIONE DI STUDIO AL LAGO TANA. [Under the leadership of Giotto Dainelli.] Volume secondo. Ricerche geografiche ed economiche sulle popolazioni. By VINIGI L. GROTTANELLI. *Roma: Reale Accademia d'Italia (Centro studi per l'Africa orientale italiana.* 2), 1939. 10×7 *inches;* viii + 298 *pages; illustrations, maps, and diagrams.* *L.*50

The results obtained by the scientific expedition sent to lake Tana under the auspices of the R. Accademia d'Italia are being published in a series of reports. This, the second volume, deals with the social life of the inhabitants of the lake Tana area. Two more volumes are to follow. The author has adopted a style which will appeal to the general reader, as well as to the more serious student of strange peoples.

The groups dealt with are the Amhara Christians, Amharic speaking Muhammadans, Uòito (Waito), Falàscia (Falasha), and Camante (Kamant). The method used was direct questioning through an interpreter and the time spent in the country was only a few months, during which many other subjects claimed the attention of the scientists. It was found that all these tribes speak Amharic as their daily language, though the Falasha and Kamant speak also dialects of the Agau language group.

New ground was broken by the special study of the houses and huts, and numerous diagrams are given as well as many photographs of exteriors and interiors, the interiors where light is difficult being particularly successful. One feature that is mentioned is the height of the beds, raised as a precaution to guard the children against hyenas; it is pointed out with a touch of humour that there is no rail to keep them from falling out. Children were estimated at two per family and there was an excess of women over men.

Different systems of land tenure are mentioned; general conditions resemble those in Europe in the Middle Ages. The status of churches, church lands, priests, and monks is discussed; that of the "slaves" in relation to the family which employs them is much the same as it was before the Italian occupation. It is presumed that this indicates that, although freed by proclamation, the majority have elected to stay on under conditions in which they are happy and content. Those who, like the reviewer, knew the country well during the last ten years, were aware that the Abyssinian slavery bogey was being exploited as a political lever in Europe. Hailé Selassie must be given the credit of having almost abolished the sale of slaves during the few years of his reign, and it only remained for the Italian Government to put the finishing touch.

The conversion of the Muhammadans dates from the conquest of Ahmed Gran, in the sixteenth century. Shaikhs fulfil the functions of the priests and polygamy is occasional. Intervals of conflict between Christians and Muhammadans have alternated with long intervals of peaceful periods in which relations are remarkably friendly. As regards the Waito the enigma of their origin remains unsolved. They are all professed Muhammadans but are seldom seen at ablutions or prayers and are completely ignorant of the Islamic law, and their feeding is unorthodox. They have been long known as hippopotamus eaters, but the Italian Government has confiscated their weapons and forbidden the killing of hippopotamus to prevent their extermination. Cereals and not fish are the Waito's habitual food. They make and sell mill stones and their special art, the making of reed rafts or *tanquas*, is described, and there is a map of the Waito villages round lake Tana. The Falasha have attracted the attention of previous travellers on account of their professed Hebrew origin and claimed Jewish descent, but most of them are now "amharized." They enjoy religious liberty and appoint their own religious leaders; every village has a synagogue. They have no religious marriage ceremony. Divorce is possible, but not for the Rabbi, nor is he allowed to re-marry after the death of his first wife; in this they resemble the Amhara Christian priests. Food, which is mostly cereals, must be cooked by a Falasha woman. They are skilled in all artisan trades. The Kamant are strictly agricultural and pastoral; their feasts are a mixture of Christian, Hebrew, and pagan elements.

The last chapter gives lists of the various markets with a map and there are lists of cereals, spices, and food crops with their local and scientific names. A full bibliography is given and the work of previous travellers is freely quoted and acknowledged; an index, where so many local and strange names are introduced, would have added to the full enjoyment of a very interesting book.

R. E. C.

THE DIARY OF DR. ANDREW SMITH, director of the Expedition for exploring Central Africa, 1834–36. Edited by PERCIVAL R. KIRBY. Vol. I. Cape Town, The Van Riebeeck Society (No. 20). 1939. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 414 *pages; illustrations and portrait*

The name of Sir Andrew Smith is well known to all naturalists interested in the fauna of South Africa as the author of 'Illustrations of the zoology of South Africa,' published between 1836 and 1849. There has always been however somewhat of a mystery about Andrew Smith himself: except for two short reports printed at Cape Town after his return from the interior in 1836, no detailed account of his travels was ever published. He returned to England in 1837 and held several appointments in the Army Medical Service, becoming Director-General in 1853, shortly after which he became involved in the charges made against the arrangements for the troops during the Crimean War. He was however completely exonerated, retiring from the Service in 1858 when the dignity of K.C.B. was conferred on him. He died in 1872 at the age of seventy-five. He left behind him fourteen volumes of manuscript containing his diaries and notes, and these were presented to the South Africa Museum at Cape Town by his nephew, Mr. A. S. Michie, in 1912. Two of these volumes contain the journal here printed for the first time.

Dr. Smith was born in humble circumstances in Roxburghshire in 1797. Like so many other Lowland Scots he obtained by his industry and hard work a good education and qualified in medicine at Edinburgh. He entered the Army Medical Service and was ordered to the Cape of Good Hope in 1820, where he was able to indulge in his favourite pursuits of natural history and anthropology. He was several times employed by successive governors in confidential missions to the Kaffir and other tribes beyond the frontier. The most important of these was in 1830 when he was sent by Sir Lowry Cole, the Governor, to report on the southern part of what is now Natal which had been devastated and entirely depopulated by Chaka, the Zulu chief. He reached the Tugela and visited Dingaan, Chaka's successor, at his kraal on the Umslatosi river.

About this time a number of people in Cape Town became interested in the exploration of the country north of the colonial boundary and in the possibility of commercial enterprise; an association was formed for the purpose of furthering these ends. Contributions were collected locally and in England and a sum of about £1000 was raised; the Royal Geographical Society was approached, but there is no evidence of any contribution, though the Society financed the subsequent expeditions of General Sir J. E. Alexander and of Livingstone. Andrew Smith was appointed to command the expedition, which included several technical experts. The party left Cape Town in June 1834 and travelled by Graaff Reinet and Colesberg to Philippolis in what is now the Orange Free State Province. Dr. Smith then spent some months exploring the upper waters of the Caledon river and what is now Basutoland, where he visited Moshesh, the well-known chief of the Basutos at his stronghold, Thaba Bosiu. He returned to Philippolis in December and travelled through what is now the Orange River Colony and across the Vaal river to Kuruman, where he was welcomed by Dr. Moffat, the much-beloved missionary and father of Mrs. Livingstone. Here he remained for some little time while his messengers were sent to Mzilikazi to arrange a visit to that renowned Matabele chief, then living in what is now the Marico district of the Transvaal; the present volume of the diary ends on 8 May 1835 before he started farther north.

The diary contains a great deal of information in regard to the conditions prevailing in the country which later became the Orange Free State. There was no organized government, and the Griquas, Corannas, and the various Kaffir tribes

spent most of their time raiding each others' cattle and fighting among themselves. There were a few Dutch settlers north of the Orange river which formed the northern boundary of Cape Colony, as the Great Trek did not take place till some years later. Dr. Smith made many inquiries into the ways and habits of the various Basuto tribes, many of which were hitherto unknown even by name, and he also describes many of the animals and plants met with. These formed the basis of his subsequently published 'Zoology of South Africa.' The diary is a mine of information about the state of those regions which had previously been visited by but few educated travellers such as Burchell, Truter, and Somerville.

Professor Kirby has done his part of the work well; he has gathered together in the introduction a large amount of information about Andrew Smith and the expedition, and has reprinted an excellent short life of Smith published in the *Proceedings* of the Berwickshire Naturalist Club in 1876 by his nephew, Alexander Michie. It is a pity that he did not endeavour to identify the various animals and birds mentioned; this might have been very easily accomplished with the help of the Museum authorities in Cape Town and Pretoria. It would also have been more convenient to have published the map in the first volume instead of holding it back for the second which may not appear for some little time, as it is difficult to follow the route of the expedition in a modern atlas.

We shall much look forward to the appearance of the second volume, which will contain Andrew Smith's account of his visit to the Matabele before they settled around Bulawayo, their final home. W. L. S.

DARK SUBJECTS. By H. L. WARD PRICE. *London: Jarrolds*, 1939. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 288 *pages; illustrations and end-paper maps.* 16*s*

The author of this book spent 25 years in Nigeria as an Administrative official, and at the time of his retirement in 1937 he had been for some years the Resident or Commissioner in charge of the province of Oyo, a province twice the size of Wales and containing 1,340,000 inhabitants. He speaks therefore with unusual authority and a very intimate knowledge of his "dark subjects."

When Mr. Ward Price joined the Colonial Service in 1912 Nigeria was still the baby of the British Empire. In many areas a few years only had passed since "human hands and feet had been exposed for sale in the local markets." In the Southern Provinces administration was direct, orders being given to chiefs by officers who were generally ignorant of the local language, customs, and taboos. Yet, in Mr. Ward Price's view, these officers effected a great deal of good in a very short time. The direct system encouraged action, whereas nowadays there is a tendency to spread responsibility, so that if a scheme fails nobody in particular can be blamed. Many hard things are said about the indirect system and the reader will sometimes wonder whether Mr. Ward Price really believes in the policy to which he was himself a partner. Yet the book as a whole provides ample evidence of the success of this policy. Even a German critic, Dr. Eckart von Sydow, who visited Nigeria in 1936, admitted in an article sent to the *Berliner Tageblatt* that "the beneficial influence of the colonial administration is visible on every side," and that "the indirect method of operation, using the native chiefs as intermediaries, results in an all but 100 per cent. absence of friction between black and white" (p. 235). Incidentally this same German observed that in Nigeria there was "a vast reservoir of labour-power such as we Europeans need to fulfil our task in the world. . . . Why should we Germans be shut out from all this?" Mr. Ward Price quotes the trade figures for the mandated territory (British Cameroons) to prove that Germany was given a square deal economically. In 1937 48 per cent. of the

imports into the Cameroons came from Germany and 12 per cent. from the United Kingdom, while of the exports 80 per cent. went to Germany and only 7 per cent. to the United Kingdom.

Mr. Ward Price has many exciting tales to tell of his 25 years in Nigeria, and also some very amusing ones. There is, for example, the story of the native clerk who announced by telegram to the Resident the death of the local chief: "Regret to inform you that Chief So-and-so has this day been promoted to ghost"! Funny as this sounds it nevertheless bears witness to the important belief found all over Africa that death is not degradation and dissolution, but promotion to a higher state. There are caustic remarks also about British Governors whose visits are attended by a ceremonial which is either "offensive or meaningless to a native. He wears a hat with plumes so that the Negro thinks he is under the protection of some bird. He is welcomed by a piece of cloth attached to a pole—another piece of strange magic. He stands up to make a speech while others sit—the reverse of what is right—and he takes off his hat when he ought to keep it on." But the Negro values ceremonial and surely recognizes well enough that just as he is entitled to his customs so we are to ours. Altogether 'Dark Subjects' provides excellent reading, whether or not the reader happens to be interested in Nigeria. C. K. M.

NORTH AMERICA

THE COD FISHERIES: the history of an international economy. By HAROLD A. INNIS. (The relations of Canada and the United States.) *New Haven: Yale University Press* (for Carnegie Endowment for International Peace, *London: H. Milford*), 1940. 10×6½ *inches;* xxii+520 *pages; maps.* 21*s* 6*d*

Cod has played a part in the economic development of the north-eastern corner of the American continent comparable to that played by the herring in north-western Europe. This long and detailed study traces the development of the fisheries, which stretch from Cape Cod to Labrador, from the end of the fifteenth century to the present day. They were first exploited by France and Portugal, countries with a large Roman Catholic population and a supply of cheap salt for drying the fish. By the second half of the sixteenth century Spain and England were actively interested in the fisheries, but the decline of Spanish and Portuguese fishing left England and France as serious competitors in this valuable trade, which was not only contributing to the prosperity of English and French west coast ports, but also helping to spread Spanish specie over western Europe. With the extension of the fisheries southwards to New England settlement became more pronounced and the increase of slavery in the West Indies opened up new markets for cheap dried fish as food for the slaves. The elimination of France in the eighteenth century as a colonial power in the north-east of the continent left the rising commercialism of New England in opposition to English mercantilist policy and paved the way for the American War of Independence. After 1783 the development of Nova Scotia and Newfoundland led to friction with the United States which continued throughout the nineteenth century. It is the economic background of these fishery disputes which the author emphasises, bringing out fully the importance of changing methods and changing markets. Professor Innis handles with great skill the complications of what he rightly calls "an International Economy." His work is based on very extensive research, but it must be admitted that the wealth of detail makes this a difficult book to read. More care might, too, have been taken over English place-names. Thus East Looe appears as Eastlowe (pp. 67, 97, and index), Barnstaple as Barnestaple (p. 67) and Barnstable (p. 140), Bridg-

water as Bridgewater (p. 140), Lymington as Lymmington (p. 198), and Teignmouth under its old form of Tinmouth (p. 292). Such minor faults do not seriously detract from the value of a work which will be indispensable for an understanding of the economy of the cod fisheries and of the economic background of much diplomatic activity. T. S. W.

TANGIER ISLAND: a study of an isolated group. By S. WARREN HALL. *Philadelphia: University of Pennsylvania Press* (*London: H. Milford*), 1939. 9×6 *inches;* xiv+122 *pages; illustrations and sketch-maps.* 9*s*

Tangier Island lies in the middle of Chesapeake Bay, 6 miles south of the Maryland–Virginia boundary. The area of the island is just over 3 square miles, two of which consist of marshy ground. The author has made a survey of the social organization of the small community of about 1100 persons who inhabit this rather unattractive spot. He introduces his study by an interesting account of its early history, in which the most important events are the strong development of Methodism, largely due to one Joshua Thomas, and the occupation of the island by the British in 1812–13 as a base of operations against Baltimore. The descendants of Thomas still live on the island and nearly half of the population is connected with the Thomas family, while Methodism is still a forceful influence. This detailed account of the present occupations and social customs of a remote social unit makes clear the need for further work of this kind in other areas. Social anthropology need not confine itself to the study of the customs of primitive peoples. The maps which illustrate the volume are not very satisfactory and it is a pity that the author did not devote more space to his geographical account of the island. E. W. G.

FLORIDA: a guide to the southernmost state. Compiled by the Federal Writers' Project . . . for the State of Florida. (American Guide Series.) *New York: Oxford University Press* (*London: H. Milford*), 1939. 8×5½ *inches;* xvi+600 *pages; illustrations, map in pocket, and plans.* 13*s*

This is one of the first of the U.S. Guide Books to be produced under the auspices of the Federal Writers' Project branch of the W.P.A. (Work Projects Administration). Its object has been to make a complete summary of all essential information on the State, much of which has hitherto only been available in specialist or scattered sources. This is not a pocket edition: its 600 pages are designed for use on the desk, book-shelf, or in the motor car. More than 400 specialists are listed as consultants. A pocket in the back cover contains a loose 40×25-inch map of Florida in four colours, and the text is illustrated by over 150 photographs.

The guide begins with general information and a list of Florida's one hundred annual events, ranging from Regattas to Shuffle Board Tournaments, from Orange and Tomato and Flower Festivals to Fishing Contests, which latter take place practically all the year round, both in salt and inland waters. There is a Christmas meeting of the Association of "Tin-Can Tourists" (*i.e.* motor-trailer outfits) of the World which counts thirty thousand members. Part I outlines the "Florida background," the section naturally of most interest to the general reader. Part II deals with twelve principal cities, from Jacksonville in the north to Key West in the extreme south, 100 miles off the Florida mainland on a coral island, and a jumping-off port to Havana. Part III, "The Florida loop," fills two-thirds of the volume with twenty-two carefully planned tours, covering coast, river, rail, and 10,000 miles of hard-surface roads. Reference to place or subject is covered by a full index of thirty-three pages, in addition to a summarized historical chronology and a particularly good bibliography, both recent and historical.

From the information given in such admirable proportion it is only possible to select a few facts that indicate its range. The section on Florida's geology, mainly limestone derivatives, explains to the reader why crops extending over 6° of latitude range from cattle, pine woods, and turpentine in the north, to citrus orchards in the centre, and early vegetables and small fruits in the south. A tidal coast-line of 3750 miles yields a rich harvest, from fish to shell-fish, from turtles to sponges. The east coast phosphate beds yield 60 per cent. of the world's supply.

Even cursory perusal gives the impression that the theatrical sophistication of Miami and its coastal counterparts, which attract over one million winter tourists annually, are by no means all of Florida, which is a continuation of the United States "deep South"; Florida is essentially a maritime State and its highways parallel those in Mexico. Some intriguing facts may be taken at random. Fossil remains show that the three-toed horse existed in Florida aeons before the Spaniards disembarked their European counterparts. The "Conchs," who form an appreciable element of Key West's population, are descendants of Cockney Londoners, with a negro strain acquired *via* the Bahamas. The "Cracker," or small up-country settler, got his name from the long whips used for bullock-driving in pre-railroad days. A Hurricane Research station operates from Gainville, facing the West Indies.

The W.P.A. Guide to Florida will be supplemented by similar reviews of Virginia, West Virginia, and Maryland, now in preparation. Such guides, if published with the addition of a final survey of United States territory, will constitute a milestone of progress in the vast and still too-little-known areas of the American States. In the meantime the volume before us provides a reference which every geographer and every traveller to Florida will welcome.

W. S. B.

CENTRAL AND SOUTH AMERICA

TO THE LOST WORLD. By PAUL A. ZAHL. *London: George G. Harrap and Co.*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 242 pages; illustrations and sketch-map.* 11*s*

RIDDLE OF HELL'S JUNGLE: expedition to unexplored primeval forests of the river Amazon. By SCHULZ-KAMPFHENKEL. *London: Hurst and Blackett*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* ix + 252 *pages; illustrations and sketch-maps.* 16*s*

These books are the popular accounts of the expeditions of young scientists to some of the remoter regions of northern South America. The young scientist of to-day has to plan and equip himself with great elaboration if he is to collect properly and acquire all the data which give an ecological value to his collections; moreover film-making, photography, and diary-writing have to satisfy increasingly exacting standards, and may be necessary for the liquidation of financial difficulties. The writers of both these books leave nothing to chance in their preparations; they make use of the hydroplane as a matter of course; live on the country as far as possible; and endure every kind of hardship and danger. The books are not merely records of scientific exploration, they are exciting stories of adventure with an authentic ring and, above all, completely free from the inaccuracies and irrelevancies of the literary-artistic traveller. It is to be hoped that the authors will not be the enemies of their own promise, and that the working-out and publication of their scientific results will be shown, as it should be, to be the chief aim of their expeditions.

Paul Zahl is a young American biophysicist who went to British Guiana late in 1938 to collect the ant fauna on the summit of Roraima and on the surround-

ing bare or forest-clad slopes and plateaux of the Pakaraima range; and to study the life-history and social organization of the huge and deadly black ants, *Dinoponera* and *Paraponera*. On arriving in Georgetown he chartered the sea-plane piloted by the invaluable Art Williams, who was of such assistance to the recent Boundary Commission, and took as his companion a hard-bitten young diamond prospector named Chislett. They flew straight to Tumareng, a diamond settlement on the Mazaruni river, made it their base for re-fuelling, and waited for the fine weather needed for a reconnaissance flight over the Pakaraimaș. Eventually Williams landed them on a sand-bank in the upper Mazaruni not far from an Indian village where there was a missionary, dropped a warning note over the village, and agreed to meet them again at Tumareng on February 15. The water rose during the night and began to cover the sand-bank, and all the stores and equipment would have been lost if the party had not been rescued just in time by boatloads of Akawai Indians from the village, Waramadong. Here fourteen drogher Indians were enlisted to lead the expedition up Roraima, which was approached by way of the Kamarang gorge and Uitshi river, the ascent being eventually made up the familiar ridge at the south-west side of the mountain. On the Uitshi a magnificent new fall, a quarter of a mile high and more than a hundred feet wide, was discovered and has been named in honour of King George VI (*Geogr. J.* 93 (1939) 521–2). The party spent a long time exploring the Kamarang gorge and living among some very primitive Indians, collecting ants, looking for diamonds, and studying two great new falls. Roraima itself was ascended on two successive days, and the story of the second ascent occupies some twenty pages of really exciting descriptive writing, although Zahl does not quite appreciate the extraordinary character of the vegetation of the summit. The return journey to Tumareng is dismissed very summarily, perhaps through fear of anti-climax.

In spite of minor repetitions—there is too much of the Lost World and the steaming jungle—the story is told with enthusiasm and considerable artistry, and whether he writes of pork-knockers, djiggas, ants, wood-skins, waterfalls, or diamond-digging, the author is both interesting and accurate. He is, in fact, so sincere and objective that he may perhaps be forgiven that "chronological alteration of certain incidents and episodes" in order to suit the texture of his narrative, to which he confesses in his preface, though this admission inevitably arouses misgivings. A serious omission from the map, particularly as they are mentioned in the text, is that of the Attabarau falls, seen by Father Cary-Elwes in 1919, and evidently in the close vicinity of the two great new falls which are so well described and photographed in this book.

Schulz-Kampfhenkel (why no Christian name?) and his two friends, Gerd Kahle and Gerhardt Krause, were members of the German Amazon-Jary Expedition of 1935–37. Their aim was to explore and chart the Rio Jary and its tributaries to their sources near the boundary of Brazil and Cayenne, to make collections of the mammals in this region, and to study the ethnology and sociology of the native Indians inhabiting these forests. A hydroplane was taken for reconnaissance flights and mail-carrying, and also to provide the members of the expedition with "practical experience for the benefit of the further and greater explorations that Germany, with her brilliant record in the history of discovery, is better qualified than any other nation to undertake." The expedition, assisted by the Reich and the Brazilian Government, was planned with almost incredible efficiency, as witness an equipment list which included anything from the simplest barter with natives to the most modern electric sound-recording apparatus. All three were experienced airmen, and between them they could map the rivers, shoot and skin the mammals, take the photographs

and films, and prepare descriptions of the ecology and sociology of the fauna and native tribes. It is only to be regretted that the botanical side was entirely omitted, and that when the arrowheads, steeped in curare, of the Oayapi were discovered and duly added to the collection, no attempt was apparently made to trace the sources of the ingredients of the poison.

On its arrival at Pará the expedition was detained for a long time in securing permits and allaying the suspicions of the Brazilian Government. Eventually the hydroplane and the boats, with crews of cross-bred Caboclo Indians, assembled at Arumanduba, on the left bank of the Amazon above the mouth of the Jary. As on Zahl's expedition, the hydroplane was used only at the outset for reconnaissance flights and messages, and the great difficulties of air travel over tropical forests and rivers which are a series of cataracts with many small intervening islands is well brought out in both books. The German plane came to grief on the Amazon quite early in the story. The German expedition proceeded up the Jary, past the formidable cataracts of San Antonio, and before long met the first of the Aparai Indians who was making a solitary cruise downstream in order to sell macaws to the rubber-collectors. This contact was the turning-point of the expedition. The Indian was persuaded to guide it up to his village near the confluence of the Ipitinga with the Jary. The Germans succeeded by peaceful penetration and propaganda in persuading the village to let them live near by; they won the confidence and even the friendshi of thep Indians and spent many months here ensuring the success of their studies and of further penetration towards the frontier. They told the Indians that the ruler of their far-off clan is "Papae Grande Sciencia," the Great Chief Science, and that he wanted to see examples of everything Indian and of all the wild animals of the neighbourhood in return for barter. By this means they persuaded the Indians to make vast collections for them. Trips were made up tributaries and every kind of hardship and danger from sudden death or starvation was patiently endured. The boatswain, Greiner, who joined the expedition at Pará, died from fever. The friends were sometimes separated for weeks, and their labours and the safety of their lives were often a race against the periodical rise or fall of the rivers which make the cataracts impassable and delay or even cut off communications of all kinds. Accompanied by the more faithful of the Aparai, the expedition succeeded in reaching the even more remote Oayana Indians and, finally, the Oayapi Indians who are under their protection. Satisfactory relations with these were established only with great difficulty, but eventually the ethnographic studies were made.

One cannot but feel admiration for these young German explorers and scientists. Ruthlessly efficient, subtle and patient, they are still somehow likeable, and they make friends with the Indians and are kind to them. Their individual personalities do not emerge clearly, and the impression is that they are all out for the New Germany and for Science, Science winning on points until the last page, whereas Zahl wants to enjoy life usefully and is out for himself and for Science, about fifty-fifty. This story is told in the present tense, and the translation is good.

Both books are illustrated with excellent photographs and useful sketch-maps, but neither has an index. N. Y. S.

SIMON BOLÍVAR. By THOMAS ROURKE. *London: Michael Joseph*, 1940. $9 \times 5^{1}_{2}$ *inches;* xiv + 386 *pages; illustrations and map.* 15*s*

As a biography of Bolívar Mr. Rourke's book is adequate. Its author knows the physical background and makes full use of the available printed sources (and of private information, though its origin and the extent of its contribution are not

stated). The style, nearly colloquial at times, is smooth: perhaps too much so, for the relief is a little flat. The point of view is narrowly personal: Bolívar's immediate companions are subordinate, as are events and personalities east of the Andes. Probably the most interesting are the chapters on Bolívar's earlier wanderings in Napoleonic Europe and the occasional exposition of his political views, for the skirmishing between small and ill-equipped forces that decided the fate of the continent is too muddled to arouse enthusiasm. Mr. Rourke does however show that Bolívar considered himself as much Conciliator as Liberator; and that he failed in the one aim as signally as he succeeded in the other, leaving Central and South America at his death divided into so many mutually antagonistic states, was due to factors beyond his control. But the restoration of unity, which Bolívar's campaigns so ably shattered and for which his pan-American projects were worthless, is what matters most now. Mr. Rourke does not explore the geographical, economic, or social aspects of this problem; like his hero he deals in abstractions. J. P. H. M.

AUSTRALASIA AND PACIFIC

WATER INTO GOLD. By ERNESTINE HILL. 4th ed. *Melbourne: Robertson and Mullens*, 1938. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 328 *pages; illustrations and sketch-maps.* 7*s* 6*d*

In her latest book Miss Hill describes the discovery and development of the Murray river and its sandy lands, and paints pictures, in words, of life on and near its waters to-day and yesterday. She also dwells on the hardships the pioneers had to face and the difficulties settlers still have to overcome.

There is nothing of special geographical value in the book. Like the earlier volume, it glosses over the hard facts with a film of fancy and is apt to give some readers a wrong idea of conditions and progress out yonder. It is true that in many respects life alongside the Murray has been made easier and that much good work has been done there: a chain of towns and thousands of green acres of vineland and orchard are visible proof of it. But much more remains to be undertaken. Men still pray for rain in this part of the continent. The district has neither enough people nor a port, though this latter could remain in the Gulf of St. Vincent. The river surface is too low and lifeless; it could be raised much higher and be the scene of tremendous activity: rail and road transport should be eliminated wherever possible in Australia.

Written and produced under the auspices of the Australian Dried Fruits Association to commemorate the Jubilee of the commencement of their industry by the Canadian brothers Chaffey in 1887, the book is liberally illustrated and should appeal to many readers. S. U.

DRAMA OF OKOKOLO: the social and ceremonial life of the Elema. By F. E. WILLIAMS. *Oxford: Clarendon Press*, 1940. 9×6 *inches;* xxvi + 464 *pages; illustrations and sketch-maps.* 30*s*

This is the eighteenth report of the Government Anthropologist for Papua. In some respects it is the best of an excellent series, if only because the Elema are in themselves more interesting than the subjects of some of the earlier reports. More conservative than their neighbours, they have retained much of the rich ceremonial life characteristic of the Gulf Papuans. For this among other reasons, the author departs from his former practice of making his picture of the group on which he is reporting as complete as data and space would permit, and has built his book around one institution. His general account of the people and their environment, compressed into 140 pages, is intended chiefly to pro-

vide a setting for detailed treatment of an elaborate cycle of ceremonies known as *Hevehe*, "a Drama, with the bush, the village, and the beach for its Stage, and the whole community for Actors." The cycle, if completed, lasts from ten to fifteen years. Beginning with the preparations for making masks of painted bark-cloth to be worn by the initiates, it reaches a dramatic climax when the masked youths, representing spirits, descend, at dawn, from the huge peaked building within which the secret parts of the ritual are carried on, and draws to a leisurely close when the spirits have gone down to the sea and all their paraphernalia are destroyed. The reader need not be an anthropologist to realize from these vivid pages that *Hevehe* is "a cultural achievement of no mean order." In a critical examination of its place in the life of the community Mr. Williams stresses its value in providing the native with "an absorbing interest as well as a unique means of expressing himself and of satisfying various social, psychological, and material needs."

The book is generously illustrated with sketches and photographs, dramatic, apposite, and technically excellent, with the welcome addition of three plates showing the designs of the masks in colour. The publisher has provided a worthy format for an outstanding contribution to our knowledge of Papua.

B. B.

THE WORK OF THE GODS IN TIKOPIA. By RAYMOND FIRTH. Vol. 1. (London School of Economics: Monographs on social anthropology, No. 1.) *London: Percy Lund, Humphries and Co.*, 1940. $9\frac{1}{2} \times 7$ *inches;* ii+188 *pages; illustrations and diagrams.* 7*s* 6*d*

This is the first of two volumes describing a series of Polynesian seasonal rites. As a contribution to the study of Polynesian religion, it is of special value because of the artificial, intellectualistic, and metaphysical interpretations which have been prominent in this field. In the absence of adequate ethnographic evidence, students have long been bewildered or misled by the verbal thaumaturgy of "philosophies," "archaic cults," and "unthinkable voids." Such figments will not bear scrutiny against the solid body of fact reviewed by Dr. Firth. The pragmatic character of Polynesian religion and its close relation to social organization, rank, and economic pursuits emerge clearly from this excellent ethnographic record. The cycle of ceremonies is minutely described, and discussion of numerous points of detail make this book indispensable to those interested in the scientific study of primitive religion and of Polynesian religion in particular.

R. P.

CARTOGRAPHY

PLANE AND GEODETIC SURVEYING FOR ENGINEERS. By DAVID CLARK. Vol. I. Plane surveying. 3rd edition revised by JAMES CLENDINNING. *London: Constable*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xvi+620 *pages; diagrams.* 27*s* 6*d*

This book, by the late David Clark, Professor of Civil Engineering, University of Dublin, was first published in 1923. A second edition, revised by the author, was published in 1932. The volume now under review is the third edition, and has been revised by J. Clendinning, formerly Surveyor-General, Gold Coast. It must be realized that the book was written by an engineer for the instruction of engineering students, and it was not intended to be a textbook for professional surveyors. Though it has now been revised by a distinguished surveyor it still retains its original character.

In addition to full descriptions of all the survey instruments and methods that are likely to be of use to engineers, there are chapters on the measurement

of areas and volumes, on the setting-out of works, and on hydrographical survey. To the chapter on linear measurement has been added a description of the use of a steel tape in catenary. This method of linear measurement, combined with the increased accuracy of angular measurement, made possible by the use of modern theodolites and targets, has halved the errors that may be expected in a theodolite traverse. In the chapter on office computations, the errors that are likely to be found in traverses and the methods of adjusting, or distributing, these errors are fully discussed. The problems that arise when a network of traverses has to be adjusted also receive attention. Amongst surveyors these problems have been discussed interminably, and without any definite results, because no precise solution is possible. The best solution will be that which first arranges the traverses in the order of their relative accuracy, and then gives to each its appropriate weight. The man who is best able to assess the accuracy of a traverse is not the computer, but the surveyor under whose supervision it was carried out.

In the introduction, the importance of working from the whole to the part is explained, but this might receive more attention in the body of the book. Many students overlook this point. The provision of a rigid framework for a survey by means of a theodolite triangulation is barely mentioned. Even though a triangulation may be difficult and expensive, it usually justifies the time and money spent upon it.

As the title implies, this volume deals only with small surveys, in which the earth may be treated as a plane surface. The methods necessary for the survey of larger areas, and the problems involved, are to be found in Volume II, of which a revised edition has been published. J. E. E. C.

ECONOMIC AND HISTORICAL GEOGRAPHY

WORLD ECONOMY IN TRANSITION. By EUGENE STALEY. *New York: Council on foreign relations*, 1939. $8\frac{1}{2} \times 6$ *inches;* xii + 340 *pages; sketch-maps.* $3.00

Mr. Staley has written a valuable and thought-provoking book, which is very apposite at the present moment. To geographers its interest lies in his analysis of international trade, the location of centres of world industry, and the future course of world economy. The first section demonstrates the effect of the gigantic strides in the development of transport and communication in recent decades upon the industrial organization of the world, and the increasing interdependence of national economic systems. Sources of supply of raw materials and foodstuffs are world-wide, and the concentration of industries in the most favourable locations and their fullest development require, with modern mass-production, world-wide markets. For the economic welfare of the world it is essential in his view that this trend should continue. Yet in the last few years, for political reasons, the opposite has prevailed, and national self-sufficiency has been the aim. Mr. Staley recognizes that the ultimate question is one of values; that, for example, a nation may prefer a strong rural population at the expense of a cheap food supply. He also sees that the process of transition from national to world economy may well be very unpleasant for an industry previously protected by tariffs, and that the industrialization of countries devoted to monopoly cultures will raise difficulties. But these are to him matters for adjustment by an international authority, a question too vast to be discussed here. Mr. Staley however puts forward suggestions for the first stages of this transition which are worthy of attention. G. R. C.

GENERAL

THE MEDITERRANEAN IN POLITICS. By ELIZABETH MONROE. 2nd edition. *Oxford: University Press*, 1939. 9×5½ *inches;* x+260 *pages; sketch-map.* 10*s*

MEDITERRANEAN PROBLEMS. By GORDON EAST. (Discussion Books, No. 55.) *London: Thomas Nelson and Sons*, 1940. 7½×5 *inches;* 228 *pages; sketch-maps.* 2*s* 6*d*

The second edition of Miss Monroe's lively and informative analysis of Mediterranean politics, though it closes at the beginning of 1939, is by no means out of date. Being careful to keep her facts distinct from her opinions, she provides a survey of those considerations which, however the international situation may alter, must be taken into account by the interested powers. Each power and its Mediterranean territories are considered in turn in their political, economic, and strategical aspects, and, what is of particular value, she has attempted to evaluate the less ponderable moral bonds and relationships. These considerations are enlivened by personal reminiscences of travel. Her chapters on the French North African colonies are especially interesting.

Mr. East's book, a useful and up-to-date summary of the historical geography of the Mediterranean, relates clearly the course of politics to the geographical environment. He is careful to state both sides of each problem fairly and to leave judgment to the reader. He is a little uncertain where Spain is concerned: it is hardly correct to refer to modern Spanish dialects as "various dialects of Castilian," for Castilian was only one dialect which imposed itself on others. Fig. 50 (linguistic divisions) distinguishes Portugal from Galicia, though the text treats their languages as identical. Mr. East's argument would have been strengthened by mentioning the movements for autonomy in both Galicia and Valencia, for which linguistic support was adduced. The sketch-maps are numerous and, with a few exceptions, clear, but not always consistent among themselves. There is an unfortunate slip, circumferences for radii, below Fig. 18. On p. 106 Strado should read Strada; on p. 186 Levantina should be Levante. The book may be recommended as compressing much material and thought into a remarkably small space. G. R. C.

THE MONTHLY RECORD

SURVEY ATLAS OF ENGLAND AND WALES

After an interval of thirty-six years Messrs. Bartholomew have issued a second edition of their Survey Atlas of England and Wales. On the whole, few changes have been made. The main feature of the Atlas is the seventy-seven layer-coloured plates on the scale of 2 miles to the inch: the plates of the original edition, with the necessary corrections, have been used again, though there are changes in the colouring of the layers. The blue of the sea is stronger, and the browns heavier, while for the higher levels a chalky purplish tone has been used. The effect of this is not to improve the general appearance of the sheets.

Most of the introductory text and matter has been omitted, retaining only the population table, the chronological list of the maps of England, and the glossary of place-name elements. Among the general maps, the railway map is reproduced on half the original scale and the ecclesiastical and parliamentary maps omitted, their place being taken by a road map on the scale of 1/1M, showing the principal Class A roads. The revision of the "Products and industries" sheet seems occasionally haphazard: Sandwich, Littlehampton, and other south coast towns are marked as shipbuilding, but the East Kent coalfield and the engineering works at Oxford are omitted, and names such as Corby and Scunthorpe do not appear. A correspondent has also drawn our attention to the fact that the place-name glossary has not been revised: errors such as sarn, road, for causeway; blaen, summit, for source; rhiw, hill or slope, applied only to roads, have been allowed to stand.

THE IRON INDUSTRY IN LUXEMBURG

As a result of military operations almost the whole of the continental resources in iron and steel have passed under German control. From the modest output of about 3·7 million tons of ore (metal content) obtained from the Reich, including Austria and Czechoslovakia, in 1938, Germany now commands an additional annual production of at least 30 million tons from other countries (this includes Sweden but not the 3 million tons from North Africa). At the same time Britain is now largely deprived of her main sources of imported ore. Germany on the other hand is deprived of essential steel alloy materials by the blockade (*The Economist*, 29 June 1940).

With the collapse of France the metallurgical industry of Lorraine–Luxemburg is confronted with new problems, and as far as the Grand Duchy is concerned, a significant phase in the development of the industry has been brought to an end. Readjustments amounting to a reversion to the conditions under which iron and steel production first rose to importance are likely to be made at an early date. In Luxemburg, as in France, large developments followed closely upon the introduction of the Thomas-Gilchrist process for the treatment of the *minette* ore, rapid expansion taking place after 1879 under the protection of the Zollverein. In subsequent years the controlling interests fell into German hands though not without bestowing substantial advantages upon the industry in this small country. Thus the production of ore rose from 2 million tons in 1880 to over 7 million tons in 1913, while the output of pig iron rose from a quarter of a million tons to 2·5 million tons, or more than 3 per cent. of the world total, over the same period. Similarly steel production rose from a negligible quantity to 1·3 million tons or 1·7 per cent. of the world total.

Though the Great War caused a considerable reduction in output the iron industry survived and was afterwards reorganized. Since the formation of the Customs Union between Luxemburg and Belgium in 1922 almost all the

German-owned properties passed into the hands of French, Belgian, and Luxemburg companies. Production of both *minette* and pig iron however has seldom exceeded that of pre-War years as the following figures from the Annuaire Officiel, Luxemburg, show:

	Average annual output in metric tons	
	1909–13	1934–38
Ore	6,320,000	5,120,000
Pig iron	1,950,000	1,920,000

But the post-War period was one of increased efficiency in ore extraction and furnace technique. It was also a period of search for new markets owing to the cessation of free imports into Germany, the home market of necessity being small. These were eventually found in Britain, Germany, and the Netherlands; India and the Far East; U.S.A. and Argentina. Moreover the Aciéries Réunies de Burbach, Eisch et Dommeldange-Terres Rouges interests were merged in 1926 to form one of the two most powerful metallurgical combines in Europe, possessing 26 blast furnaces in the Grand Duchy, 3 in the Rhineland, 2 in the Saar region, and 1 in Lorraine.

The vital coke and coal supplies were drastically affected by the Treaty of Versailles. Previously excellent and abundant fuel was obtained from the Ruhr, and the largest iron and steel concerns also held concessions in Westphalian mining and coking districts, notably in the Eschweiler basin near Aachen. For several years after the War however the situation remained unsatisfactory, but gradually imports of German coke regained much of their old predominance and by 1929 amounted to 70 per cent. of the quantity consumed in Luxemburg (C. Wagner, 'La sidérurgie luxembourgeoise,' Luxemburg, 1931). Other sources were drawn upon, especially from Belgium (Sambre-Meuse and Campine fields), the traffic being facilitated by the new Customs Union. Small quantities of coke were also imported from the Netherlands and the Saar. Belgian coke, except from the Liège district, is inferior to the German in quality and inadequate in quantity, although it came duty free and over a shorter haulage distance. The requirements of fuel were thus secured, the total consumption in recent years being somewhat greater than in 1913.

Thus having solved the problems created by the last war and having adapted itself to new economic conditions, recent events have compelled the Luxemburg iron industry to face these perplexities anew. The solution of the present crisis must also take into account the approaching exhaustion of the *minette* field within the Grand Duchy. The deposits probably contain not more than 280 million tons of ore and at the present rate of consumption can only last another twenty-five years. Considerable imports of *minette* ore are in fact already made from across the Lorraine border, but of greater significance, geographically speaking, have been the additional steps taken by A.R.B.E.D.-Terres Rouges to safeguard the future. Extensive properties and mines have been secured in Brazil where there are large reserves of high-grade ore. Nearer home, land has been acquired along the banks of the Terneuzen Canal near Ghent, a few miles from the North Sea coast, where a large smelting plant may eventually be established. It is noteworthy that several recently constructed steel works in different parts of the world, *e.g.* Baltimore, Port Kembla, N.S.W., Cardiff, and Genoa, are also situated at or near the seaboard and are largely if not wholly dependent upon imported iron ore. K. C. E.

TANGIER

A short but interesting publication by Lieut.-Colonel W. B. T. Abbey, 'Tangier under British rule, 1661–1684,' draws attention to the brief period

during which Tangier, now more important strategically than ever, was in British ownership. It raises once again interesting speculations as to the many "might have beens" if only Charles II had been able to win the day against his parliament and provide the proper financial support of which this colony, brought under the control of England at the same time as the island of Bombay as a part of the dowry of Catherine of Braganza, was always starved. This book contains little that is not available in the much larger and much more closely documented work, 'Tangier, England's lost Atlantic outpost, 1661–84,' by Routh and published in 1912; but, as the latter has long been out of print, a new summary statement will be welcome to many, especially in view of the present concentration of interest in the Mediterranean and its gateways. Lieut.-Colonel Abbey outlines how Tangier came to be British and gives some account of British governors and regiments stationed there, as well as discussing in considerable detail the disposition of the forts, walls, and famous mole, all of which were destroyed or made unusable on the British withdrawal, but of which many important traces remain. W. Fg.

A POSSIBLE DISCOVERY OF SOUTH AMERICA IN 1494

Among the manuscripts of the John Boyd Thacher Collection in the Library of Congress is a small narrative, inserted between a document relating to a voyage to India in 1501–02 and a report of an Indian priest who visited Venice in 1502, which refers back to the earlier documents in the collection from which it was omitted "by inadvertance". These earlier documents had been sent from Spain to Venice by Angelo Trevisan, who got his material from Peter Martyr. The interest of this additional document is that it describes a voyage, made by ships sent from Hispaniola by Columbus, in the course of which pearl fisheries were discovered and a stretch of something like 2500 miles of the north coast of South America was followed. In a paper dealing with the document ("A narrative of the discovery of Venezuela (1494?) in the Thacher manuscript on Columbus . . .," printed in the Proceedings of the Third Convention of the Inter-American Bibliographical and Library Association, Washington, D.C., 1940), Mr. W. T. Wilson brings forward arguments to show that the voyage was possibly made in 1494 and that Columbus knew of the report and the result of the voyage when he planned and undertook his own voyage of 1498 to the same region. To reach this conclusion a number of suppositions have to be made as to the authorship of the document and a reference in it to the "third navigation": from the context, if this reading is correct, it seems impossible to connect it with any date other than 1494. If however Mr. Wilson's conjectures are accepted the importance of the manuscript is obvious since it records the discovery of South America by Spaniards in 1494. Further, since the expedition was composed of five caravels, its results would probably be widely known and might have been taken into consideration by La Cosa when he depicted Cuba as an island on his great map of 1500. These are speculations in which Mr. Wilson does not indulge: he is content to set out his views on the manuscript with moderation and to leave the interpretation to "the great jury of professional expert Americanists." J. N. L. B.

BROKEN HILL

The June number of the *Annals* of the Association of American Geographers contains a short but interesting survey by C. M. Zierer of the mining community at Broken Hill in New South Wales. This region has produced over the past sixty years a remarkable and varied supply of minerals of which silver, lead, and zinc are the most important. Broken Hill is wholly dependent for prosperity on the extent and marketable value of its mineral wealth. There is no alternative

attraction in the barren rocky ranges, beyond the use of the salt-bush vegetation for the poorer forms of pastoralism. Professor Zierer shows that the peak of mining activity at Broken Hill is already past, as although there are reasonable prospects of profitable mining for some years to come, the mineral resources have known limits. The population dropped from 35,000 in 1913 to 26,000 in 1933, and since 1937 the amalgamation of both mining and processing enterprises has led to marked unemployment and to further shifts from the town.

The working of the minerals at Broken Hill has never been a simple matter. The absence of water supplies for domestic or industrial uses, the high rate of evaporation which detracts from the value of water storage in reservoirs, the lack of coal and of strutting timber, have all combined to make mining operations costly and laborious. The lay-out and architecture of the town and of the thin ring of surrounding settlements are evidences that there has never been an assurance of permanent prosperity. The main building material is corrugated iron; the main feature of architecture, the sheet-iron fences to keep out drifting sand. This threat developed quickly with the exhaustive "wood hunts" all round the settlement for mining timber. The circle of hamlets round Broken Hill—Silverton, Day Dream, Southern Cross, Pinnacles, and others—indicates mining enterprises, the existence of which was measured by years, while that at Broken Hill has at least lasted three generations. All the human exploitation of this region has an ephemeral appearance.

The fortunes of Broken Hill are reflected minutely in the slumps and booms of Port Pirie at the head of Spencer Gulf. This small town grew up first as a wheat-exporting centre and then as the link between Broken Hill and the outside world. Through it, fuel, timber, mining equipment and food reached the mines of the interior. With the passing of years, the port saw not only the despatch overseas of crude ore from Broken Hill, but also the growth of concerns for processing silver, lead, and zinc. This form of industrial development brought a considerable British element into the population at Port Pirie, whereas during the earlier years of the town's history the Greek and Italian communities were noticeable. The continuation of the metallurgical industries is plainly dependent upon the course of events at Broken Hill. H. W.

SNOW FORMATIONS ON MOUNTAINS OF HAWAII

In the *American Journal of Science* for February 1940 Mr. Chester K. Wentworth in an article entitled "Ablation of snow under the vertical sun in Hawaii" describes snow-banks in the summit area of Mauna Kea, Hawaii, over 13,000 feet, which were found to be deeply pitted and spiked. Visiting the mountain in the course of geological studies on 24 July 1939, a time when the sun passes vertically across the region in lat. 19° 50′ N., the author found pits or sun-cups in the snow-fields about 4 feet deep and separated by spikes, which were not only precisely vertical, but also strikingly oriented in line with the east-to-west movement of the vertical sun. These altitudes were quite independent of the direction and amount of slope of the ground, or of local direction of the wind, and according to the testimony of previous climbers were produced in not over a week's time. Both the arrangement of the features in east–west rows and their perfectly vertical direction seemed to the writer to require a nearly vertical noon-day sun for the wastage of snow. At the margin of the drifts the snow-spikes were isolated and perfectly symmetrical without the slightest inclination to lean one way or another, but farther from the edge they were merged at their bases and the pits become shallower, showing no bare ground at distances of more than 50 feet. In the inner parts of the largest banks the snow surface was nearly intact, being only broken by a few pits here and there.

The condition of the pits and the snow surface generally points to evaporation as the main cause of the ablation, which proceeds very rapidly in the dry air of upper Mauna Kea. With July midday temperatures of about 50° F. there must be a moderate amount of melting as well, but the ground is so permeable that there is no visible run-off.

Recorded observations are insufficient to indicate whether formation of such sun-cups and sun-spikes is usual at a certain seasonal stage of wastage of the snow or not. They differ, it is stated, from *nieves penitentes*, but the reader is not reminded of the distinguishing characteristics of the latter. Friends of the author who had visited the mountain a week or so earlier found no indication whatever of pitting in the heavy snow-drifts encountered, and they had the novel enjoyment of tobogganing in Hawaii.

SOURCES OF ALUMINIUM

The sudden raid upon the aluminium cooking utensils in this country in the interests of aircraft production must have led to some reflection on the world distribution of bauxite, the raw material from which almost all aluminium is made. To quote the definition in the world survey of mineral raw materials prepared by the United States Bureau of Mines: "Bauxite, the chief commercial source of alumina, is composed essentially of a mixture of diaspore, bohmite, and gibbsite, and owes its pre-eminent position to its high alumina content, and relatively low content of silica and other impurities. . . . Based upon present-day metallurgical knowledge, the reduction of bauxite requires an abundance of cheap electrical power." As noted in the July *Journal* (pp. 45–6), the alternative raw material for the manufacture of aluminium is cryolite, found almost exclusively in South-west Greenland; but its importance is small compared with that of bauxite.

The most important bauxite resources are in France near the French–Swiss and French–Italian frontiers. The French collapse has thus meant the transference of enormous supplies for aircraft manufacture from the Allied to the totalitarian states. The German gain is the more serious because the hydro-electrical power in Austria, Czechoslovakia, Italy, and Norway gives every facility for transforming bauxite into aluminium. Hungary is the second producer. In 1939 the yields of bauxite from this country, over 500,000 metric tons (S. V. Chamber, *Report on economic and commercial conditions in Hungary*, H.M. Stationery Office, 1939), exceeded those of the United States and were not far behind those of France: an interesting development in a country whose statesmen have often protested since 1920 that all mineral wealth of any significance in the Kingdom of Hungary was given to the "Successor States" by the terms of the Treaty of Trianon. The United States ranks third in the production of bauxite; the main source of supply is the Arkansas river basin. Surinam is the fourth, and close behind the Dutch colony come Yugoslavia with important resources in Dalmatia, and Italy with the supplies of the Abruzzi mountains. British Guiana, the Netherlands East Indies, and Russia all have useful stocks of bauxite, but their resources are not comparable to those of the first six regions listed. It is plain therefore that the actual possession of some of the best stocks of bauxite, or easy access to these stocks, rests with the totalitarian powers.

It should be noted that the production of bauxite is distinct from the production of aluminium. For example the United States is the first producer of aluminium with imports of bauxite from Surinam ('The mineral industry during 1937,' vol. XLVI. Ed. G. A. Roush. London, 1938). Germany is the second, drawing supplies of raw material from Hungary and Yugoslavia. No other countries are in the same class as these two for the manufacture of aluminium.

Canada comes third, relying almost entirely on imported bauxite, especially that of British Guiana. Hungary, Yugoslavia, and Surinam, which possess such notable supplies of the raw material, are insignificant as furnishers of aluminium.

H. W.

STAR PLACES FOR SURVEYORS

For some long time the five Nautical Almanacs of the world, American, British, French, German, and Spanish, have divided the work of calculation and interchanged results, so that of the 25 Polar Stars and 489 others whose apparent places were tabulated in the Nautical Almanac, none were actually computed at Greenwich. Between the five, the places of 1279 stars were given, but repeated in different almanacs so that the space for 3327 stars was occupied. No single almanac contained enough stars for the accurate determination of time and position, so that places had to be taken from the various almanacs; but they belonged to different fundamental systems. At the meeting of the International Astronomical Union at Cambridge, Mass., in 1932 Dr. Comrie had proposed to reform this unsatisfactory state of affairs; and at the following meeting at Paris in 1935, it was resolved that all the star places should be based upon the Third Fundamental Catalogue (FK_3) of the *Berliner Astronomisches Jahrbuch*, and that the places of the 1535 stars it contained should be published in one volume annually. The first volume, for 1941, has just been published: the calculations made in Berlin, Paris, San Fernando, and Washington; the organization, collation, independent checks, and proof-reading done at Greenwich; and the cost of publication borne by the British Government. For everyday work each Nautical Almanac will publish the places of about 200 principal stars: thus the British for 1941 has one circumpolar and 207 others. Those who for very accurate work want more stars will turn to the volume 'Apparent places of fundamental stars, 1941' just published by Order of the Lords Commissioners of the Admiralty, price £1 10*s*. This volume will be indispensable to surveyors who employ the prismatic astrolabe, and very convenient for those who prefer the quadrantal method with the theodolite; and if in present circumstances the prospects of such international cooperation are dim, the volume for 1941 will be an example for a better future.

OBITUARY

EUSTACE ROLFE GUNTHER

The death of Mr. E. R. Gunther, at thirty-seven years of age, the result of a tragic accident, is a great loss to oceanography and marine biology, for he was a brilliant field-worker, distinguished for research in a wide variety of subjects.

He was educated at Winchester and Caius College, Cambridge, and in 1924, when the *Discovery* Committee began its investigations in the Antarctic, he was one of the first to be appointed to the scientific staff; he was still in their service at the time of his death.

The first subject to which he directed his attention was the abundant plankton or drifting life of the Southern Ocean, on which the rich Antarctic fauna depends for its subsistence. After prodigious work on the detailed analysis of samples he published in collaboration with Professor A. C. Hardy a memoir which throws much new light on these organisms, on their migrations, and on the factors which affect their distribution. Later he devoted his well-earned leave to further studies of the plankton and with other workers at Cambridge completed a study of the fatty and vitamine content.

In 1931 at the suggestion of the Admiralty, the *Discovery* Committee agreed to make an examination of the Peru Current, and Mr. Gunther was placed in charge of the work in the *William Scoresby*. In spite of difficulties which would have meant failure to anyone with less tenacity of purpose, he achieved complete success, returning with a full series of observations covering a distance of over 2500 miles from the Magellan Straits to Ecuador. He published the hydrographical results, a model of careful analysis of the data, in the *Discovery* Reports, but with characteristic thoroughness he felt that before doing so it was necessary to make a close study of all the earlier literature. The summary of his results, published in the *Journal* for July 1936, is preceded by an instructive historical account, in which our knowledge of the Peru Current is traced from its earliest beginnings in the fourteenth century.

In other branches of work he obtained equal success. For a time he was in charge of whale-marking operations at South Georgia, during which he made valuable observations, now in the press, on the habits of whales. He also conducted a comprehensive trawling survey of the plateau between the Falklands and the mainland, and it was on the results of this and other surveys of the area that he was engaged when war broke out. Foreseeing the urgent necessity for preparation for war he had joined the Territorials as a sapper in 1937, receiving his commission a year later; the accident in which he met his death occurred while on active service with a searchlight unit.

Mr. Gunther was a man of many fine qualities, among which his enthusiasm, thoroughness, determination, and sturdy independence were pre-eminent. Observations at sea were carried through with scrupulous accuracy despite all difficulties, and he appeared to have no regard for the extreme discomforts inseparable from work in small ships in the rigours of Antarctic weather. To the preparation of his results he brought untiring industry and a thoroughness which could leave no by-way unexplored. He took a keen delight in all natural beauty and was an accomplished artist in water-colours: as successful with landscapes as he was with the delicate sketches of marine animals which illustrate papers in the Reports. In Mr. Gunther the *Discovery* Committee has lost a most loyal member of its staff, while his colleagues and his many friends will mourn the untimely death of a man of great achievement and much promise. He married Dr. Mavis Carr in 1929, and had a son and two daughters. S. K.